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HOW TO USE THE COMMODORE 64®

A User's Guide to Expansion, Applications, and Maintenance

An Alfred Handy Guide



by Michael Boom

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AN ALFRED HANDY GUIDE

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This Handy Guide is not a publication of Commodore Business Machines and should not be used in lieu of the instruction manuals that accompany their products. All information regarding Commodore computers may not be accurate or completely up to date.

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INTRODUCTION

The Commodore 64 is one of a new generation of home computers designed to bring many powerful features and full memory capacity to the home user. Its low price makes it affordable to many people who have never owned or used a computer before, and its versatility gives them a full range of services and entertainment. With the Commodore 64 you can balance your checkbook, or keep the books for a small business; write letters to friends, or generate a professional looking report; play tick-tack-toe, or fly spaceships through hostile space. Its uses are as varied as your imagination.

This Handy Guide will give you an overall idea of what you can accomplish with your Commodore 64 computer and introduce you to its workings. It also gives you an idea of products and programs available to expand your computer system.

We'll discuss the 64 in a logical order, starting with Chapter 1, where we take an overall look at a typical 64 system: what the parts are, what they do. Chapter 2 shows how to get your computer running. In Chapter 3 you learn to use the keyboard and the screen editor (the part of the computer that displays what you type), and in Chapter 4 we take a brief look at BASIC programming. Chapter 5 shows how to store programs, and Chapters 6 and 7 will help you build up your Commodore 64 by showing you how to expand your program library and to buy optional equipment. Appendices A and B are included to give you the names of some of the hardware and software available for your computer. Appendix C lists some computer magazines of interest to Commodore users, and Appendix D is a handy, self-contained guide for the complete novice on how to load and run programs.

If you want to get your computer "up and running" immediately, read Chapter 2, then jump to the Appendix for instructions to load and run programs. If you can wait, a closer look at the Commodore 64 computer system will help you better understand and control your computer.

1. A COMMODORE 64 COMPUTER SYSTEM

A first look at your Commodore 64 computer reveals little more than a plastic box with a typewriter keyboard. Since you have just paid good money for this helpless-looking machine, it is not surprising that your first thoughts might actually be second thoughts. It is a good time to learn or review some of the basic facts about computers.

What is a home computer anyway?! Let's look at the obvious facts first. A home computer is a machine which can perform small tasks, such as adding two numbers or displaying a small dot on a TV screen. But many machines around us are capable of doing this: a pocket calculator can add numbers; we can make dots with a pencil. What makes a computer something different?

To begin with, it can perform a wide variety of small tasks extremely quickly. This gives it the power to combine them into much larger and more impressive tasks. For instance, if the computer displays a number of small dots in the correct place on a TV screen, it can draw a complex picture. But perhaps the most important feature of the computer is that it has a memory to store lists of these small tasks. In this way, the computer has a guide to tell it which tasks to perform and in what order. A list of these tasks is known as a *program.*

You can create your own programs for your Commodore 64 or buy programs which were written by other people to run on your machine. In computer jargon, programs are referred to as *software*, to distinguish them from the rest of the computer system, the *hardware.* You might like to think of the hardware as anything that exists physically, that you can get your hands on, and software as a set of directions which causes your hardware to run the way you'd like it to. When you buy a record for your stereo system, the music on the disk is software; it tells the stereo how to make the sounds that you paid for. The needle, the turntable, the amplifier, and the other parts of your stereo are all hardware, waiting for the directions encoded in the grooves of the record to tell them what to do.

HARDWARE

Now that we know the difference between hardware and software, let's find out just what hardware is included in the typical Commodore 64 computer system. Like a stereo system, a home computer system can take many different forms depending on what peripherals you add to the 64 computer (see Figure 1.1).

THE COMPUTER

The center of the system is the Commodore 64 itself. Like a stereo receiver, it combines many com-

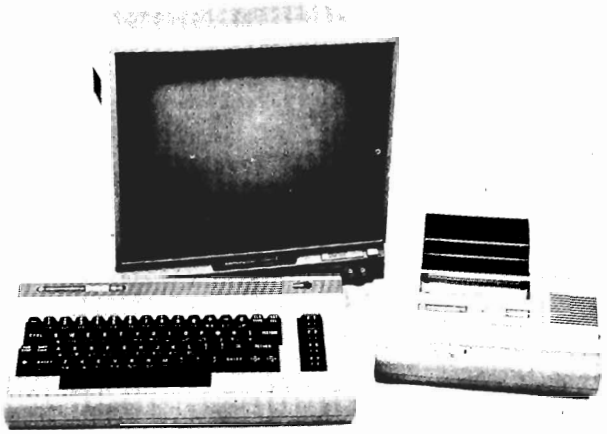


Figure 1.1 A typical computer configuration: the Commodore 64 computer, 1701 Monitor, and 1520 printer.

ponents in one package: The *keyboard*, which you can see immediately, the *microprocessor*, *SID*, *VIC*, and *memory*, which are all small chips inside the computer's body.

THE MICROPROCESSOR

The microprocessor is the heart of the computer. It is the command center, responsible for all the calculations and figure manipulations performed by the 64. It is in charge of executing the commands you give, and it controls all of the other parts of the computer, including other chips which display things on the TV screen, make sounds, and perform many other functions necessary to run the computer. The 64 uses a 6510 microprocessor, an upgraded version of the 6502 microprocessor which is used in several other popular home computers.

SID and VIC

SID and VIC are not a comedy team, and they have not starred in any recent TV specials. They are the chips in charge of your sound and video display. SID is an acronym for Sound Interface Device, and it's a music synthesizer on a chip capable of producing three voices of very sophisticated sound. VIC is short for Video Interface Chip, and produces the letters, shapes, and colors that flow across your TV screen when the computer is running.

MEMORY

Another major part of the computer is the memory required to store programs and information necessary to run the computer. These programs and information, known as *data*, are stored as tiny electric charges inside memory chips. The chips are connected to the microprocessor by tiny strips of conducting metal. We can see the memory chips in Figure 1.2.

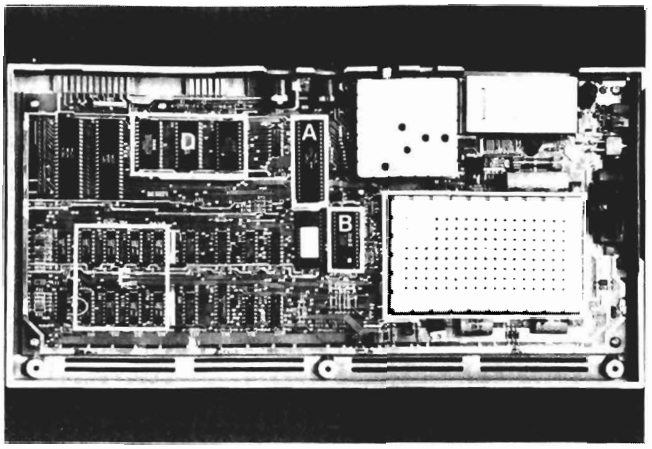


Figure 1.2 The circuit board inside the Commodore 64 computer shows (A) the 6510 microprocessor, (B) the SID chip, (C) the VIC chip (under the metal shield), (D) three ROM chips, and (E) eight RAM chips.

There are two kinds of memory used in the 64: *RAM* and *ROM*. These acronyms stand for *random access memory* and *read only memory*. To understand the difference between the two, let's think of memory as a large blackboard at school. As a teacher presents instructions and explanations to his students, he writes them on the blackboard. If he wants to present some new information, he can erase the board and write again. In a similar manner, random access memory (RAM) can be filled with data and then erased later to put in new material. The data in RAM can be easily moved around into different memory locations, and erased and rewritten at will.

Now let's imagine a student sneaking into the classroom after hours and writing something very sinister in indelible spray paint on the blackboard. The teacher will find it impossible to remove with his eraser. That message is there for good! Since it has filled up the blackboard, the blackboard is now useless for writing on, and serves only to display the student's message. This is similar to read only memory (ROM), a type of memory which stores data permanently. The computer can only read the data in ROM, it cannot erase it or write anything new on it.

There are different uses for each type of memory. ROM is used to store unchanging data that is important for making the computer work. RAM stores computer instructions and information which change from time to time.

Before we leave the topic of memory, let's discuss one other aspect. Computer memory is limited. It can only remember a finite number of things, and there are ways of measuring its capacity in units. The smallest unit of memory is a *bit*, which can only remember if something is on or off. Eight bits combine to make a *byte*, which is just enough memory to store one character of the alphabet or number system. A thousand bytes are referred to as a *kilobyte*, or *K*, and a million bytes are known as a *megabyte*, or *meg*. (Note: One kilobyte is actually 1,024 bytes and one megabyte is

1,048,576 bytes, reckoned using binary arithmetic, the type of counting a computer does. However, for our purposes, it's easier to think of them as one thousand and one million, respectively.) Since different computers come with different amounts of memory, you'll usually see them advertised with these units of memory measurement prominently displayed. The Commodore 64 has 64 kilobytes of RAM, which is how it got its name. It also has 20 kilobytes of ROM, which store the software necessary for running the computer.

THE KEYBOARD

The most visible part of the computer is the keyboard. It's our main channel of communication with the microprocessor inside. If you are familiar with typewriter keyboards, you'll see a similarity. This makes it very easy for the experienced typist to adapt to a computer keyboard. There are also a number of extra keys with little arrows and strange words on them, and strange symbols on the sides of the keys. These are used for computer functions not found on typewriters. We'll talk about them in Chapter 3.

Now that we've seen what makes up our computer, let's look at the other hardware we can add on to create a usable computer system. These other pieces of hardware are known as *peripherals*.

THE MONITOR

The *monitor* is probably the most crucial peripheral to a system. It allows the computer to communicate with us by displaying letters or pictures on the screen. The monitor's speaker is used to produce music and sounds created by the 64 and the screen lets us see what we have typed into the computer. The Commodore 64 is designed to use your TV set as the monitor. It can also use specially designed computer monitors (see Figure 1.1) which will give the Commodore a clearer picture, but which will not tune in your favorite television programs.

THE CASSETTE RECORDER AND THE DISK DRIVE

Another important peripheral is the *data storage device*. This may seem unnecessary, since we have all that memory in the computer designed to hold data. However, the RAM used to hold data has one serious problem: when the computer is turned off, everything in it is erased! This can be highly discouraging if you just spent five hours creating a program and then turned off the computer. RAM takes a steady current of electricity to keep data stored in its memory. The way around this problem is to read out the contents of memory to another device that can store data without constant power. Then the computer can be turned off, or the memory erased to be used for another program, without the first program being lost.

Why bother with RAM in the first place if it loses data so easily? Well, in its weakness lies its strength. Its ability to be erased and written to so easily, a qual-

ity called *volatility*, makes it very easy for the microprocessor to use. It is many times faster than the best data storage device, and this is important to the operating speed of your computer. By using both RAM and a data storage device, we can utilize the strengths of both—fast memory with RAM and permanent memory with the data storage device.

A typical Commodore 64 system uses one or both of two storage devices: the *cassette recorder* and the *disk drive* (see Figure 1.3). The cassette recorder is much less expensive than the disk drive and works quite well for data storage. It uses ordinary cassette tapes, and has been specially designed to connect to the 64. Data is converted from RAM into electrical signals, which are recorded onto a cassette tape in the same way that music or any sound would be recorded. Later, when you wish to load the data back into RAM, the cassette recorder plays back into the Commodore the electric signals which are interpreted and stored back into RAM as the original data.

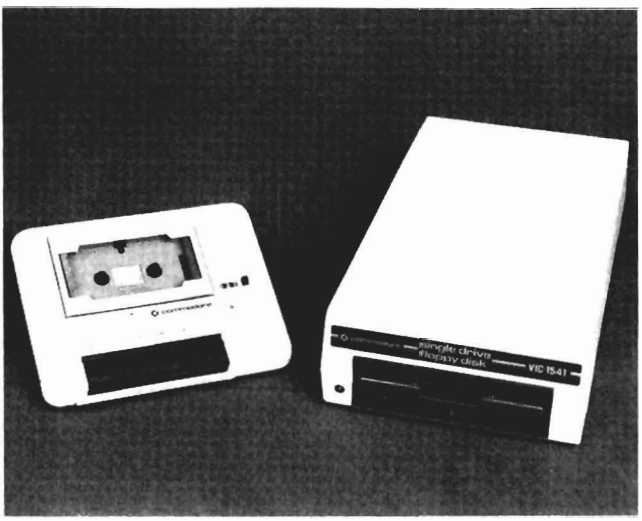


Figure 1.3 The Datasette Recorder and Disk Drive.

The disk drive stores data on a small piece of flexible coated plastic known as a *floppy disk* (see Figure 1.4). This disk is made from the same material as recording tape—mylar with an iron-oxide coating—but it is a bit thicker. It gets its name from the fact that it's very flexible and not as rigid as some other disks are. (Hard disks are discussed in Chapter 6.) The floppy disk is enclosed in a tough, square, cardboard envelope which protects it from creases and fingerprints, deadly enemies of the data stored on the disk. You can see the floppy disk through an oblong hole in the envelope, but the exposed disk should never be touched. You might fingerprint it!

The disk drive has a recording head which moves back and forth across the disk through this hole while the disk is rotating. This recording head can record electrical signals onto the disk in much the same way that the recording head of the cassette recorder records onto a cassette. The contents of the Commodore RAM are converted into signals which are then stored on the disk. The signals can be read back later and reconverted to data to be stored in RAM. What is the

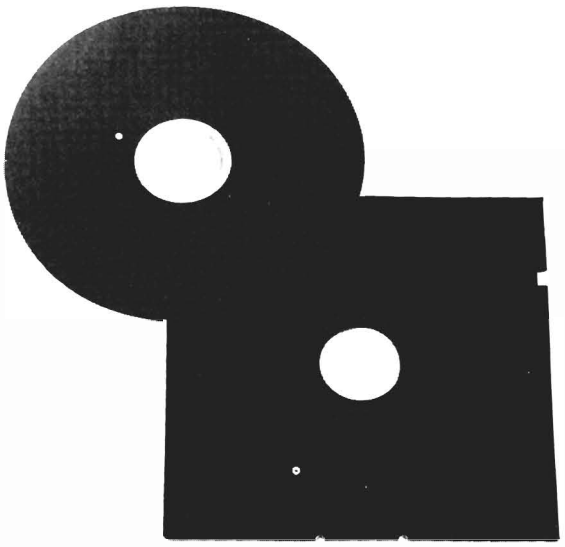


Figure 1.4 Floppy disks, opened and unopened.

advantage of a disk drive over the cassette recorder? It seems to record data very much like the cassette recorder does. Why pay all that extra money for one?

The disk drive's main advantages are speed and data accessibility. It can load and store data ten to twenty times faster than a cassette recorder. It can also store and retrieve data from the disk in any order. How does that help us? Let's use an analogy. Consider trying to find your favorite song on a record album. If you have the album on cassette, you must fast forward and rewind until you find the song. This can take some time and effort, especially if the song is somewhere in the middle of the album. If you have the album on a 33 rpm record, you can look at the album jacket for its location and set the needle down directly at the beginning of the song with little searching or effort. In a similar manner, data on a disk drive can be found almost instantaneously by the record head moving across the disk. Each disk has a *directory* on it that lists (in magnetic signals) all of the programs and information contained on the disk. The disk drive can look at that directory and go directly to the data required.

Once it finds the data, it can load it much faster than the cassette recorder can. A long program on cassette might take eight minutes to load (once found). The same program would load from disk in a matter of seconds. The disk drive is also more reliable, and not so likely to garble signals sent back to the computer.

PLUG-IN ROM CARTRIDGES

There's a third way to store data, although unless you have special equipment you can't do it yourself. This method is to store the data on a ROM chip as a series of circuits. Once the chip is created, the software embedded on it is generally there for good. You can buy programs stored in ROM. They usually come in a cartridge, which is plugged into an appropriate socket in the computer. The major advantage of the cartridge is that it loads instantly by plugging it in and turning

the computer on, a very simple procedure. Cartridges are also very durable, and can withstand a lot of rough handling that disks and cassettes can't.

We've now seen the hardware included in a typical Commodore 64 computer system: the Commodore 64 computer itself, a monitor to display information, and a program storage device (cassette recorder or disk drive) to store programs and information. Although any functional 64 computer system needs at least this much hardware to get good use from it, many peripherals can be added to increase its power and versatility.

SOFTWARE

A computer without software can't do anything. It might as well be used as a very large paperweight or converted into a very curious planter. To make it run, we need to supply it with software.

Software comes on a variety of storage media. We can buy it on floppy disks, on cassette, or on a plug-in ROM cartridge. And just as books and printed material are written in many different languages, such as Dutch or Japanese, so is software. Let's look at two languages commonly used with the Commodore 64 computer system.

MACHINE LANGUAGE

All commands received by the microprocessor must be in *machine language*, the internal language of the computer. It's a very fast and efficient language favored by advanced programmers, but it's not easy to use. Machine language is written as a series of numbers which, when converted into electrical pulses, tell the microprocessor what to do. Since the numbers put into the computer speak directly to the microprocessor, the microprocessor can act very quickly on them. For this reason, most arcade style video games are written in machine language, since machine language is quick enough to provide exciting video displays. Writing a program in machine language can take a good deal of time and effort, but the results are worth it.

BASIC

Since most people do not like to talk in numbers, it's fortunate that we have other computer languages that are much easier to use. In computer parlance, something easy to use is known as "user friendly." One of the friendliest computer languages in use today is *BASIC* (which is an acronym for Beginner's All-purpose Symbolic Instruction Code). When we write a program in BASIC, we use English words to command the computer. In order to use BASIC on the 64, we must first have a machine language program which will interpret for the microprocessor. This program take our BASIC English commands and translates them into machine language. We will take a much closer look at BASIC programming in Chapter 4 and cover the many other languages available for the 64 in Chapter 7.

Commodore 64's are sold with a variety of soft-

ware included. We'll look at the software most commonly included in a simple computer system.

THE OPERATING SYSTEM

One piece of software included with the 64 is called the *operating system* (*OS* for short). The folks at Commodore have called their operating system the *KERNAL* (but I doubt if it does chicken right.) The KERNAL is a machine language program which runs all of the fundamental functions of the computer. With no OS, the computer would just sit in front of you when turn it on, doing nothing. The KERNAL tells it how to respond to the keyboard and switches, how to display on the monitor, how to receive programs from the disk drive or cassette recorder, and thousands of other things. You must have an OS in the computer to run anything. The KERNAL, which is contained in a chip inside the 64, starts working the instant the computer is turned on.

COMMODORE BASIC

BASIC is included on a ROM chip inside each Commodore 64 computer. The BASIC chip allows you to run programs you purchase which are written in BASIC. As discussed earlier, the BASIC chip contains a machine language program which interprets the BASIC commands for the microprocessor. BASIC is the most commonly used language among Commodore users who write their own programs.

THE DISK OPERATING SYSTEM

If you buy a Commodore VIC-1541 disk drive, a machine language program is included called the *disk operation system*, or *DOS* for short. DOS comes on a ROM chip which is located inside the disk drive. DOS lets the disk drive and the 64 exchange data, and controls the disk directory and the drive motor. Without DOS, the disk drive wouldn't work. Cassette owners without a disk drive need not worry about DOS; it has nothing to do with the cassette recorder.

This is the software common to most Commodore 64 computer systems. There is an incredible amount and variety of additional software available to make your Commodore 64 perform all sorts of interesting and useful jobs. We will look at some in Chapter 7.

2. RUNNING YOUR COMMODORE 64

Setting up and running a Commodore 64 computer system is not a difficult job. The computer system that most people own includes the computer, a monitor, a program storage device, and some game controllers. The computer and the peripherals have all been designed to connect to each other very easily. The

only tool you may need is a screwdriver. Just follow the instructions in the user's guide.

Before you start hooking things up, take a look around you for a good place to set up. You'll want a table or desk where you can sit down at the computer as if it were a typewriter. There should be room for the disk drive or cassette recorder nearby, and the monitor should be close for easy viewing. If your monitor is small enough (perhaps a 13-inch screen), you might set it up directly behind the computer. If it's a large console TV, set your computer table in front of it at a close enough distance for easy viewing. You'll find that the cables connecting all of the peripherals will set some limits on their distance.

TAKING STOCK

You should have:

- the Commodore 64
- your TV set or special monitor
- a power supply
- a TV switch box
- a video cable
- a *Commodore 64 User's Guide*

SETTING UP

If everything is accounted for, first hook the computer up to your monitor or TV set, then plug in the power cords, carefully following the instructions in your *Commodore 64 User's Guide.*

Once everything is connected, turn on the TV set. Then trip the rocker switch labelled ON on the right side of the computer to test whether the computer and monitor work. After a few seconds, the screen should light up with light blue characters on a dark blue background which say:

```
**** COMMODORE 64 BASIC V2 ****
64K RAM SYSTEM
38911 BASIC BYTES FREE
READY.
```

A small square called the *cursor* should be blinking just below the READY.

If nothing shows on your screen, check to make sure the channel is set correctly on your 64 as well as the TV set. (The TV might also need some fine tuning.) If all the cables are connected, and things still don't work, consult your dealer for help.

Now that we know the computer and monitor work, we can turn them off and hook up our program storage device. Turning the computer off before connecting new equipment or plugging in cartridges is a good habit to get into, since it is possible to damage cartridges if you plug them in with the power on. Again, follow the appropriate instructions in your User's Guide to connect either your Datasette recorder or your VIC-

1541 disk drive to your computer. If you have game controllers (joysticks or paddle controllers), you can connect them by plugging them into the ports on the right side of the 64 labelled, appropriately enough, CONTROL PORT 1 and CONTROL PORT 2.

POWERING UP

Now that the system is all hooked up, it's time to turn it on. Although you can turn the components on in any order, I recommend that you turn on the monitor and disk drive first so that they can warm up. If you have a program on a cartridge that you want to run, now is the time to plug the cartridge in the slot to the right rear of the computer (just behind the power light.) Remember that the computer must be off while inserting cartridges to avoid damage to the cartridge! Once everything is set, turn on the 64. If you have a Datasette recorder, it doesn't need to be turned on, since it starts when you press its control keys.

If you have a program to load using the disk drive or cassette recorder, we will discuss how to load it in Chapter 5 and Appendix D at the end of this Handy Guide. In order to load them, you'll need to know something about how to use the keyboard.

3. USING THE KEYBOARD

We know from our look at hardware in Chapter 1 that the heart of the Commodore 64 is the microprocessor, a small chip located inside the computer. The keyboard lets us communicate with the microprocessor. Each time we press a key on the keyboard, a signal is sent to the microprocessor (in machine language) and a character appears on the screen. When the microprocessor communicates with us, it does so by printing messages on the monitor. Let's imagine the monitor screen as a bulletin board where we post messages for the microprocessor to read, and it in turn posts messages for us. In Chapter 1, we also talked about the KERNAL, a machine language program that's always in the computer, running everything. There's a special part of the KERNAL that keeps track of our bulletin board and lets us exchange messages with the microprocessor. This is called the *screen editor*. In order to talk to our computer, we need to know the rules by which the screen editor works.

TRYING THE KEYBOARD

The easiest way to learn about the screen editor and keyboard (see Figure 3.1) is to try them out. Go ahead! Type anything at random. If you would like, try all the different keys to see what they'll do. You won't hurt anything on the computer. If, for any reason, the computer *locks up*, meaning it won't respond to the keyboard, simply turn the 64 off and then on again: everything will be cleared up.

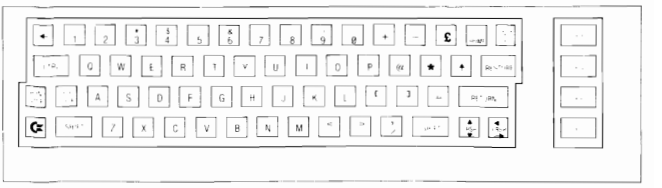


Figure 3.1 The C64 keyboard.

You may notice several interesting things. You might get strangely shaped characters on the screen, or perhaps characters of a different color. The location of your screen printing might suddenly jump to the top of the screen. If you get yourself in a jam, (for instance, the characters have just mutated into some unreadable color), there's an easy way to set things back to normal without resorting to turning the computer off and on. First hold down the RUN/STOP key located on the left of the keyboard, then simultaneously hit the RESTORE key on the left side of the keyboard. The screen should clear, the characters will turn back to their normal color, and you can continue with your experimentation. This is called *resetting* the computer.

Sometimes the computer will print "?SYNTAX ERROR" and "READY" back at you if you press the RETURN key. This is because it's expecting specific commands in BASIC language, and we're giving it gibberish instead. Ignore it! We'll just continue with gibberish so we can learn more about the keyboard. Avoid the RETURN key if the error message bothers you.

One important thing to notice is how the *cursor* works. The cursor is the small white blinking square on the screen that acts as the type head, leaving characters and showing your typing position on the screen. If you type to the end of a line, the cursor automatically jumps back to the left and down one line. You don't need the RETURN key to do this, as you would on a typewriter. This feature is called *wraparound.*

MOVING THE CURSOR

You can move the cursor without printing characters on the screen. This way you can move easily to another screen area where you wish to type. In the bottom right corner of the keyboard, there are two keys labelled CRSR, one with up and down arrows, the other with left and right arrows. If you press the left key, the cursor moves one space down. The right key moves the cursor one space to the right. If you press the cursor keys while holding down the SHIFT key, the left one moves the cursor up, the right one moves the cursor to the left. If you hold a cursor key down, it will begin to *auto repeat* and move many spaces very quickly.

One other key controls the cursor movement, and that is the CLR/HOME key in the upper right-hand part of the keyboard. If you press it, the cursor immediately jumps from its current position to the upper left-hand corner of the screen, known as the *home* position. These three keys, along with the SHIFT key, allow us to move anywhere on the screen we wish to go without changing any of the characters already on the screen.

If you begin to type at the bottom of the screen and run out of room, you'll notice that the screen editor automatically shifts all the characters up on the screen to give you more room to type. The lines at the top of the screen are pushed upwards out of sight. This is called *scrolling*. If you want to start out fresh and clear the entire screen, hold down the SHIFT and press the CLR/HOME key we used before. This *clears* the screen by erasing all the characters and returning the cursor to the home position.

TYPES OF KEYS

There are several types of keys on the 64 keyboard. They are:

1. Character keys. These keys produce characters on the screen when pressed.
2. Editing keys. These keys don't actually produce characters when pressed, but move the cursor around, clear the screen, shift characters around on the screen, and perform other editing functions.
3. Executive keys. These keys are used to control the operation of the computer by stopping or starting a program, resetting the computer, or performing other functions.
4. Function keys. These four keys don't do anything on their own, but can be told to control different functions while running a program.

CHARACTER KEYS

Character keys (see Figure 3.2) are the simplest keys to understand. They are the letters, numbers, punctuation, and special mathematical symbols which appear on the keys in the middle of the keyboard. You press a character key and a character appears on the screen. The long space bar at the bottom of the keyboard is also a character key which produces a space as its character. Most character keys have more than one symbol on them, and might have symbols on the front as well as the top of the key. These multiple keys are used with the SHIFT, CTRL, and C= (Commodore) keys, which are editing keys.

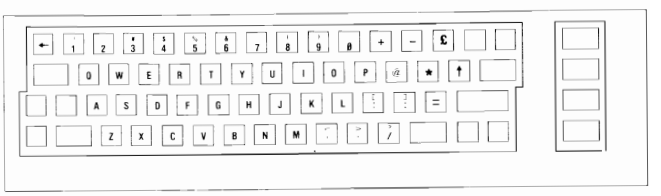


Figure 3.2 The C64 keyboard with character keys highlighted.

EDITING KEYS

The editing keys (see Figure 3.3) are located on the right and left sides of the keyboard. They let us manipulate the characters created by the character keys. Three keys in particular allow us to create all of the different symbols seen on the character keys. They are the SHIFT key, the CTRL key, and the C= (Commodore) key. Holding down one of these keys while hitting a character key will produce results different from hitting the character key alone. You might get specially shaped *graphics characters*, upper- and lowercase letters, or other symbols. Let's look at the editing keys individually.

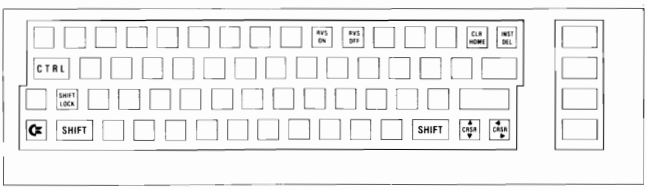


Figure 3.3 The C64 keyboard with editing keys highlighted.

SHIFT KEYS

There are two SHIFT keys, one on each side of the keyboard for your convenience. Holding down a SHIFT key while pressing a character key will usually give you the graphics character shown on the front right of the key, or the symbol shown on the top of a number key. Figure 3.4 below shows you what characters result from pressing character keys while holding down a SHIFT key.

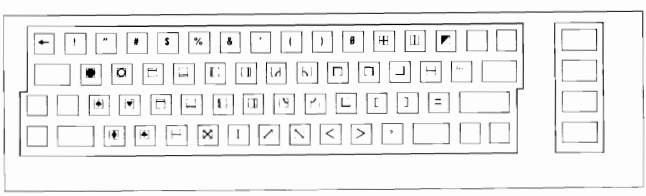


Figure 3.4 The shift key characters.

THE SHIFT LOCK KEY

The SHIFT LOCK key locks in the SHIFT key mode so that you don't have to hold the SHIFT key down continuously for extended use. Pressing SHIFT LOCK once locks the key; pressing it a second time unlocks the SHIFT mode.

THE COMMODORE KEY (C=)

The Commodore key (C=) is located in the bottom left of the keyboard. By holding the C= key down while pressing a character key, you will usually get the graphics character shown on the left front of the character key. Using the C= key with keys 1 through 8 will cause the printing on the monitor screen to change colors. These colors, as well as the graphics characters result-

ing from use of the C= key, are shown below in Figure 3.5. We'll talk more about changing character colors later in this chapter.

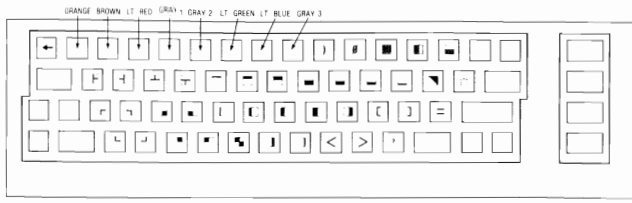


Figure 3.5 The Commodore Key characters.

THE CONTROL KEY (CTRL)

The CTRL (short for "control") key is used principally with the number keys 1 through 0. Holding down the control key and pressing a number key from 1 through 8 will cause the color of the monitor screen printing to change to the color listed on the front of the keys. Using CTRL with keys 9 and 0 will turn the *reverse character* feature on and off, which we will discuss later. Using CTRL with the other character keys can reproduce other important editing functions such as color change or cursor movements. Figure 3.6 below shows the results of CTRL use with the number keys.

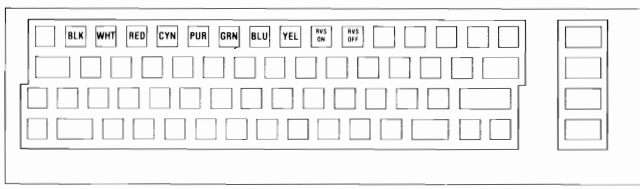


Figure 3.6 The CTRL Key characters.

THE SHIFT AND C= COMBINATION

When you first turn the C64 on, it will only print capital letters without lower-case letters. The C64 can print lower-case characters on the screen using the SHIFT and C= keys in combination. To understand how this works, we need to examine the important concept of *character sets*.

As you type on your C64, it stores each keystroke in its memory. When the computer needs to display the characters you typed on the screen, it looks at each memorized keystroke and draws the appropriate character by referring to a table. This table, which shows the computer how to draw characters for the different keystrokes possible on the keyboard, is called a "character set."

The Commodore 64 has two different character sets: *upper-case* (in effect when the computer is turned on) and *lower-case*. The upper-case character set creates upper-case letters, numerals, graphics characters, and other symbols. The lower-case character set creates lower-case letters, numerals, a smaller set of graphics characters, and upper-case letters.

When we want to type using lower-case letters, we can enter the lower-case mode by pressing the C= key and the SHIFT key at the same time. The lower-

case character set is now selected (see Figure 3.7), and the keystrokes are interpreted differently. Try it! One strange effect you might notice is that all of the characters already on the screen change as well as the new characters you type after entering lower-case mode. This is because the C64 uses the new character set for the keystrokes in its memory as well as the new keystrokes you make. Going from upper-case to lower-case mode changes all of the capital letters on the screen to lower-case letters. Many of the graphics characters are transformed into capital letters. Pressing the C= and SHIFT keys simultaneously again will turn capital letters back into graphics characters and lower-case letters back into capital letters.

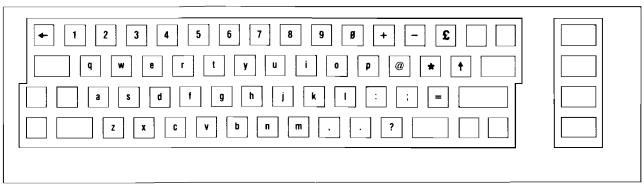


Figure 3.7 The lower-case character set.

It's important to realize that the two C64 character sets can't be used at the same time or mixed together; they remain separate, each interpreting keystrokes in its own way. Graphics symbols produced using the SHIFT key in upper-case mode are no longer available in lower-case mode, since the SHIFT key must be used for capital letters instead of graphics characters. The characters already on the screen change because they are remembered as keystrokes, not as characters, and are now redrawn according to a new character set.

In the previous sections on the SHIFT, C= and CTRL keys, we showed how they created characters while in the upper-case mode. Figures 3.8 and 3.9 below show you how the SHIFT and C= keys work while in the lower-case mode. Notice that in addition to lower-case letters, there are a few new graphics characters available using the SHIFT and C= keys, such as a check symbol and some striped squares.

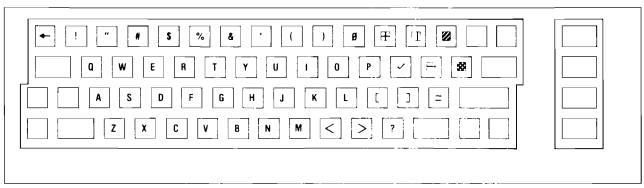


Figure 3.8 The lower-case character set with SHIFT key.

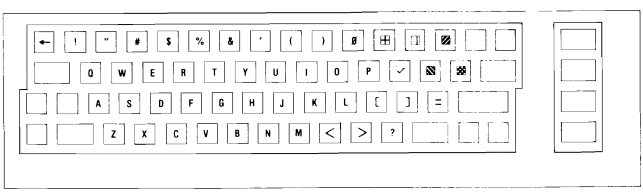


Figure 3.9 The lower-case character set with Commodore Key.

REVERSE ON AND REVERSE OFF KEYS (RVS ON and RVS OFF)

Using the CTRL key with the 9 and 0 keys gives you RVS ON and RVS OFF editing functions. RVS ON lets you print on the monitor in reverse video, in which all the characters now appear as dark blue in a light blue background. Reverse video is very handy for printing something on the screen that you want to stand out from the rest of the characters. You might think of it as a form of video underlining. Using the space bar in reverse video gives you small blocks of whatever color you are printing in, and can be used to create colorful bars. To get out of reverse video mode, use CTRL and 0 to get RVS OFF.

CURSOR KEYS (CRSR)

As we discussed earlier, the CRSR keys allow us to move the cursor around the monitor screen without disturbing any characters already there. By themselves, the left CRSR key moves the cursor one space down, and the right CRSR key moves the cursor one space to the right. Used with the SHIFT key, the left key moves the cursor one space up, the right key one space to the left.

THE CLR/HOME KEY

The CLR/HOME key used alone returns the cursor to the home position, which is the upper left corner of the screen. Using CLR/HOME with the SHIFT key not only returns the cursor to the home position, but it also erases everything else from the screen.

THE INSERT/DELETE KEY (INST/DEL)

INST and DEL stand for "insert" and "delete," and are powerful editing tools for adding and erasing characters from the monitor screen. Using this key alone gives you the delete function, which acts like a rubout key; it moves the cursor back one space each time you press the key, erasing whatever characters underneath it. Holding the DEL key down puts it into auto repeat, which makes it continue deleting without having to re-press the key for each space.

Using INST/DEL with the SHIFT key puts it into insert mode, which moves any characters after the cursor over one space to the left each time you press the key. Holding down the key starts the auto repeat, as it does with DEL. Using the INST key clears an area for you to insert characters in the midst of other characters. The space you create using INST responds a little differently to the characters you type in than a normally blank screen. We'll talk more about this aspect of the insert mode a little later in this chapter.

EXECUTIVE KEYS

There are three executive keys (see Figure 3.10) which give us immediate control over the computer's operation: the RETURN, RESTORE, and RUN/STOP keys.

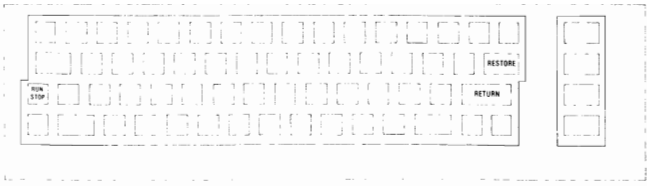


Figure 3.10 The C64 keyboard with executive keys highlighted.

THE RETURN KEY

A return key on a typewriter is used to end one line of printing and return the print head to the beginning of the next line. At first glance, that seems to be the function of the RETURN key on the C64. It actually does more than just return the printing to the beginning of the next line. Think of the RETURN key as a message to the computer saying "I'm done typing, I'm returning control to you so you can read my message." The C64 examines what you have typed after each RETURN, which is why we get so many error messages playing around with the keyboard and pressing RETURN. On some computers, the RETURN key is labelled ENTER instead, and this can be a better way of thinking about its function; it enters what you have just typed into the computer's memory, where the computer can deal with it.

THE RUN/STOP KEY

RUN/STOP gives us two functions. Used by itself, it lets us stop a program which is running so that we can enter more commands. Occasionally the STOP key is disabled by the program so that it is impossible to stop a program in the middle, where it would be too disruptive. STOP can also be used to stop a tape program from loading or to stop other computer activities.

Using RUN/STOP with the SHIFT key lets us automatically load a program from a cassette tape. We'll discuss this in Chapter 5.

THE RESTORE KEY

As you work with the C64, it's quite probable that you'll get yourself into an inescapable jam. The color of the printing might be illegible, the program we have just entered might lock up the computer so that it won't respond to your key pounding, and the STOP key might not work. The RESTORE key allows a graceful way out. It stops any program which is running, resets the computer to normal conditions and screen colors, and gives you control once again. It won't erase the program in memory, so we can go back and work on whatever problems are there. To use the RESTORE key, you first have to hold down the RUN/STOP key and then press RESTORE.

Occasionally, your C64 will get itself into some lockup that even the RESTORE key can't get you out of. In that case, you'll have to turn the computer off, then on again to start over. If you do this, anything you entered into the computer will be erased, and unless you have a copy of it on disk, tape, or cartridge, you have just lost a lot of work. Always try the RESTORE

key before resorting to the on-off method. It saves your work and sanity.

THE FUNCTION KEYS

To the right of the keyboard, in a row by themselves, stand the function keys. Try them out. If they don't do anything, don't be surprised. They aren't supposed to—yet! The function keys are designed to be flexible, and do whatever they are told to do. When you or a programmer want the computer to do something special at the push of one key, then you can program the function key to do what you wish when pressed. This operation can change from program to program depending on what action is desired. In some programs, the function keys are not used at all. In others, they might be the most frequently used keys on the keyboard. You have to read the directions that come with any program to determine how the function keys are used.

Using the appropriate function keys by themselves gives you functions 1, 3, 5, and 7 (f1, f3, f5, and f7). Use the SHIFT key to get functions 2, 4, 6, and 8, (f2, f4, f6, and f8) which are printed on the front of each function key.

WORKING WITH THE SCREEN EDITOR

As you continue working with your C64, you'll become much more familiar with the workings of the screen editor. To help you get better use of it, here are a few useful tips and ideas.

SETTING CHARACTER AND BACKGROUND COLORS

The light blue on dark blue that the C64 normally uses to print on the monitor might not be legible enough for you. If so, there is a way to change both the character color and the background color. Changing character color is easy. You merely press one of the number keys 1 through 8 while holding the CTRL or C= key to get the color you want. The colors available using the CTRL key are printed on the front of each number key.

If you experiment with different character colors, you might have trouble reading some of them; they tend to bleed into the background color. This is called *artifacting*, and it can be very distracting. Some of the character colors will work much better against a different colored background.

Changing the background color is a little more involved than changing the character color, but it's still not too difficult. If we number the available colors from 0 to 15, we can tell the computer to use one of them as the background color. The eight colors available using the control key become colors 0 through 7. For example, color #0 is black, color #2 is red, and color #7 is yellow. The eight colors available using the C= key become colors 8 through 15, which makes color #8

orange, color # 11 light blue, etc. To tell the computer the background color of our choice, we type in:

```
POKE 53281,X
```

where X is the number of the color we want. For example, if we want to turn the background white, (color # 1), we type:

```
POKE 53281,1
```

End this command by pressing the RETURN key so that the computer will look at your command. The background should now turn white!

You can experiment using different numbers in the POKE 53281 command to find a background color you like. A good combination of character and background colors for clear legibility is white characters (CTRL 2) on a grey background (POKE 53281,11). You may find your own favorite color combination through experimentation.

QUOTE AND INSERT MODES

As you work with the C64, you may notice that the keyboard doesn't respond in quite the way you think it should. You might find it impossible to get the cursor keys to work, or to use the HOME key. What you get instead are strange reverse video characters. When this happens, it usually means that you have inadvertently entered the *quote mode* or the *insert mode.*

To explain the quote mode, we must understand an important computer concept called the *string.* A string is a row of characters that you can give to the computer to print out later, to manipulate in some way, or just to remember so that you can ask for it later. To set off a string from other characters on the screen, you must always enclose it in quotes. Some examples of strings are:

```
"LADIES AND GENTLEMEN, OUR NATIONAL ANTHEM!"
"Lavonia Putra, hairdresser."

"My favorite number is 9345."
"ckek4rkvkw3oe8iu58f"

"!"
```

Any one of these strings could be used while programming in BASIC.

One very handy feature available for use on your C64 is the ability to include editing commands as well as characters in a string. You might want to create a string with the first and last sections separated by a "cursor down" control. When this string is printed out on the screen, the first half is printed on one line, the cursor then jumps down a line, and the second half of the string is printed out one line lower.

Any time you print a quotation mark on the screen, the C64 puts you into quote mode. When you press cursor movement keys and other editing keys, instead of operating as they usually do, they leave a symbol on the screen which will turn into cursor movement or

the appropriating editing function when the string is printed out later. Entering a second quotation mark will end the quote mode.

The quote mode is something you may have little use for outside of BASIC programming. It can be inconvenient, though, if you are typing away and suddenly find the cursor keys won't work. All you need to remember is that one quotation mark starts the quote mode, and that entering a second quotation mark will get you out of it.

The insert mode is similar to the quote mode in that the cursor movement and other editing keys leave symbols on the screen instead of working as they normally do. When you use the INST key, it shunts other characters to the left, leaving space to enter new characters. Typing in this newly cleared space puts you into the insert mode, where the cursor movement keys and other editing keys will not work as they normally do. To exit the insert mode, you can continue typing until you're out of the INST cleared area, or you can hit RETURN to end it.

PHYSICAL AND LOGICAL LINES

As we begin to learn how to enter BASIC commands in the next chapter, we must know how the C64 reads the lines we have entered. When we look at the screen, we see characters in distinct lines and columns. The screen editor sees things differently. What we see as one line, it may see as merely part of a longer line. To differentiate between our line and the screen editor's line, we need to name two different kinds of lines. They are the *physical line* and the *logical line*. The physical line is what we see as one line on the screen, the logical line is what the screen editor sees as a line.

Let's go back to our conception of the screen as a bulletin board used to pass messages back and forth between us and the microprocessor. When we want to send a message to the microprocessor, we type it on the screen, then hit RETURN to tell it to read what we just typed. If we've been typing other things before the message, we don't want them included in the message. The screen editor works this out by requiring a RETURN after each message. This RETURN marks the end of one message and the beginning of the next.

When we send messages to the microprocessor, we have to keep in mind that we are dealing with a simple silicon chip, not a human mind. It can't handle a message that is too long. The screen editor works this out by limiting messages to two physical lines in length. This message is called a logical line.

When we begin to give the computer orders in BASIC programming, we must be careful not to make them longer than the limit of a logical line. Any orders over two physical lines in length get truncated, and will not include everything you want the computer to act on.

4. A LOOK AT BASIC PROGRAMMING

BASIC programming is a subject that has filled many books. You won't be able to gain any kind of comprehensive knowledge of BASIC in one chapter of a Handy Guide. Instead, our object here will be to understand the fundamental structure of BASIC programming. You'll learn a few of the commands available and how to enter them, concentrating on the commands that let us load and save programs using an external storage device such as a cassette recorder or a disk drive.

BASIC is a computer language that was originally developed by John Kemeny and Thomas Kurtz at Dartmouth College in the mid-sixties. Designed specifically for beginning computer programmers, it's particularly clear and easy to use, and found on almost every microcomputer sold today. Although BASIC has developed many dialects by adding new commands and revising old ones, its fundamental structure remains the same. The new versions adapt it to the strengths and peculiarities of many different computers.

The Commodore 64 uses a version of BASIC known as Commodore BASIC 2.0. BASIC 2.0 is a simplified form of Microsoft BASIC, a popular dialect found on many other microcomputers, including the Apple and the IBM Personal Computer. It's possible to buy a more expanded version of BASIC to give you more commands on your C64 computer.

ENTERING COMMANDS

We've been talking quite a bit about commands. Now it's time to find out just what they are. BASIC commands are usually English words which cause the computer to perform specific functions. Some of the BASIC commands we'll learn about in this chapter are:

- PRINT
- SAVE
- RUN
- LIST

There are a few very important things you should know about BASIC commands on the Commodore 64. You must take some care in typing them in. Spelling counts! The computer is not a person who might guess what you mean if you type PRENT instead of PRINT. The slightest misspelling will confound the computer, and it will respond with an error message. The commands cannot be typed in inverse video, which is interpreted as garbage by BASIC 2.0. They must be typed in upper-case letters when in upper-case mode, and lower-case letters when in lower-case mode.

As mentioned in the last chapter, we give commands to the computer by using the screen as a kind

of message board. The computer tells you when it is ready for a command by printing READY on the monitor. We give it a command by first typing the command on the monitor and then entering it by hitting the RETURN key. Let's give the computer a command. Type the command RUN. If you misspell it, you can go back and correct it. Once you're ready to enter the command, hit RETURN. The computer will immediately respond with READY. RUN tells the computer to run whatever program is in its memory. Since the memory should now be blank, it has nothing to run and should merely come back with the READY prompt.

If you did something wrong, misspelled a word perhaps, then you probably got a ?SYNTAX ERROR message from the computer. This is the computer's way of saying that it did not understand what was entered. When this happens, you'll have to find out what you did wrong and re-enter your command.

Throughout your use of the Commodore 64 computer, you'll probably encounter many different error messages. You can look up the messages in an appendix at the back of your *Commodore 64 User's Guide* for a more detailed explanation. Error messages can be annoying, but without them, we would never know what we did wrong when the computer won't respond to our commands.

THE PRINT COMMAND

A very important BASIC command is PRINT, which tells the computer to print characters of your choosing on the screen. Let's try it out. First type in the command PRINT. Follow it with a space, and then whatever you want printed enclosed in double quotes ("). This expression in double quotes is called a string, a concept we examined in Chapter 3. The quotes will not be printed out on the screen when the PRINT command is executed, but all the characters they enclose will be. A sample PRINT statement might be:

```
PRINT "IN THE NEWS TODAY, ARMY ANTS OVERRAN
THE STATE OF DELAWARE."
```

When everything looks right, hit the RETURN key to enter the command. Your C64 should print out the message.

PRINT can also be used to calculate arithmetic expressions. Try entering this (notice there are no quotes):

```
PRINT 56+34
```

The C64 will respond with 90, the correct answer to 56 + 34. In computerese, it has just *evaluated* the arithmetic expression 56 + 34. Now try:

```
PRINT "56+34"
```

The C64 will print 56 + 34, which are the characters in the quotes. It won't evaluate the expression.

This is an important rule regarding PRINT: Anything following PRINT in quotes as a string will be printed out exactly as you entered it. Any expression

not in quotes will be evaluated and the result printed out. PRINT can make your C64 into a very powerful calculator. You can evaluate complex expressions like (2+67)*45/42. Experiment to see what you can do.

WRITING A PROGRAM

Thus far we have been using BASIC in the *immediate mode*. We type in a command and enter it using RETURN, and the computer executes the command immediately. If we want the C64 to do anything more than one simple command at a time, we have to use the *deferred mode*. In the deferred mode, we can enter a long list of commands in the order we want the computer to execute them. These commands will be stored in the computer's memory and executed in order at a later time.

To enter a command in the deferred mode, first type in a number. It has to be a positive integer from 0 to 63,999; no negative numbers or fractions are allowed. Now follow it with a space, and then your command. Enter this line with the RETURN key. The computer will not execute the command, but will instead store it away to execute later. For example, try entering:

```
1 PRINT "NOT NOW, LATER!"
```

The computer does not print anything. It just sits there. Let's enter another deferred command.

```
2 PRINT "BUT NOW IS LATER."
```

This command also is not executed, but simply stored in memory.

We've just created a very simple program made up of two different PRINT commands. The program is stored in the computer's memory. If we want to run our program, we enter the immediate command RUN. Try it out. The computer will now execute the commands in the program and print out two lines of characters. You can ask the C64 to RUN this program as often as you wish—the program still remains in the memory.

If you wish to see the program, enter the command LIST. This causes the computer to list any program in its memory. Try it out. The C64 will print out the two lines you entered earlier.

HOW THE C64 RUNS A PROGRAM

When the computer runs a program, it checks the numbers at the beginning of each line in the program. It then performs the commands in numerical order, going from the lowest line number to the highest line number. The numbers don't have to be consecutive, as they were in our example. For instance you could have entered the two PRINT commands as lines 10 and 20 instead of 1 and 2. The program would still run in the same way. If you had entered the two lines above in reverse order by first line 2 and then line 1, the computer would reorder the lines by their numbers and execute line 1 before line 2.

There are some commands which alter the order in which computer executes the program lines. GOTO, for example, is a command which is followed by a line number. When the computer executes this command, it will jump to the line number mentioned, start executing commands there, and then move on to the following lines. Let's try it out. Enter a third line in our program:

```
3 GOTO 1
```

Now RUN the program. Your screen will quickly fill up with text! We have programmed an endless loop. The C64 executes lines 1, 2, and 3. The command at line 3 tells it to go back to line 1, and so it does, starting all over again. Since the computer is very obedient (or incredibly simple, depending on how you look at it), it repeats the commands endlessly. Now is a good time to use the STOP key, which makes the computer stop its loop. Programmers use GOTO and other similar commands so that small programs can accomplish a great deal of work.

Since we've gone to the work of writing this incredibly valuable program, we don't want it to be erased and lost forever when we turn off the computer. Let's save it.

SAVING A PROGRAM ON CASSETTE

Before we save our program, we need to give it a name so we can ask for it easily later. The C64 will accept names from 1 to 16 characters long. Our selected name can use any of the characters available on the keyboard, including graphics characters and spaces, with the exception of the double quote. Since we'll be using the name as a string later on where it will be enclosed in double quotes, a double quote in the program name will confuse the computer. Names should help you remember what the program is, so let's name our program PRINT LOOP.

Now let's save PRINT LOOP. First, put a cassette in the recorder (see Figure 4.1), making sure it's rewound all the way to the beginning of the side. Then enter the command:

```
SAVE "PRINT LOOP"
```

The C64 will respond with:

```
PRESS RECORD & PLAY ON TAPE.
```

Now press the PLAY and RECORD keys on the recorder simultaneously. They should lock into place, and the screen will blank out in light blue. The red save light on the recorder will light up, and the recorder will begin recording your program. When it's finished, the save light will go off and the screen will come back with:

```
OK
SAVING PRINT LOOP
READY.
```



Figure 4.1 Loading cassette into the Datasette recorder.

Press the STOP key on the recorder, and rewind the cassette to the beginning.

Your program is now stored on cassette. Remember when saving any program to use a name of your own choice in place of PRINT LOOP.

SAVING A PROGRAM ON DISK

Saving a program to disk is even easier than cassette storage, and takes much less time. You'll need a specially prepared disk called a *formatted disk*. If you've just bought some new disks, chances are they're not formatted. Chapter 5 tells you how to format them.

The disk drive stores programs using a 16 character name just as the cassette recorder does, so we'll use the same name: PRINT LOOP. To save it, make sure the drive is turned on (green light is on), and then open the drive door and insert the disk, label side up, with the oblong slot in the envelope towards the drive door. (See Figure 4.2) Close the drive door. Then enter the command:

```
SAVE "PRINT LOOP", 8
```



Figure 4.2 Inserting a disk in the 1541 disk drive.

The 8 after the command tells the C64 to save the program to device # 8, which it knows as the disk drive. Without the 8, it would save it to the cassette recorder. After entering this command, the disk drive will begin spinning the disk and the red light will come on. The screen will display:

```
SAVING PRINT LOOP
```

When it is finished, the red drive light will go out and the drive will stop spinning. The monitor screen will respond with a READY. Your program is now saved.

ERASING THE MEMORY

Now that we have stored our program on either cassette or disk, let's enter LIST to see what's in the C64's memory. Our program should still be there. When we save a program, it's duplicated on the program storage device and not erased from memory. Here's a command to wipe the C64's memory clean: NEW. Enter NEW, and now enter LIST. The computer lists nothing! The C64's program memory is now clean, and our program is gone. Fortunately, we saved it elsewhere.

LOADING A PROGRAM FROM CASSETTE

Now we need to get our program back into the C64's memory. Here's how to load it from cassette. First, insert the cassette in the recorder (make sure it's rewound all the way). Then, enter:

```
LOAD "PRINT LOOP"
```

(PRINT LOOP is the name of the program we saved earlier.) The computer will respond with:

```
PRESS PLAY ON TAPE.
```

Press the PLAY key on the recorder. The screen will blank out in light blue, and the recorder will begin looking for your program. When it's found the program, the recorder will stop running, and the screen will respond with:

```
OK
SEARCHING FOR PRINT LOOP
FOUND PRINT LOOP
```

Start the program loading by pressing the C= key on the computer. The screen will blank once again, the recorder will start up, and your program will begin loading. When it's loaded, the recorder will stop and the C64 will respond with:

```
LOADING
READY.
```

Press the STOP key on the recorder. Your program should now be loaded. Enter LIST to see if the

program is there. It should be. If not, try again, and make sure the cassette is rewound.

LOADING A PROGRAM FROM DISK

To load a program from disk, first insert the program disk in the drive if it's not already in. Then enter:

```
LOAD "PRINT LOOP", 8
```

5. FILE STORAGE: CASSETTE AND DISK

While you work with your computer, you will begin to accumulate programs and data. These saved programs and data, known as *files*, might be thought of in the same way you would think of files kept in a file drawer. Each file on disk or cassette might contain a program or a list of information, such as your address book or a recipe file.

As your collection of disks and cassettes grows, you'll probably have the experience of losing some of your files through faulty hardware or careless handling. Learning more about file storage can prevent this. In this chapter, we'll discuss the hows and whys of file storage: how to buy the proper cassettes and diskettes for your system, how to store your files safely, how to keep your hardware in top condition, and other useful facts. This chapter is divided into two parts, one for cassette storage on the Datasette Recorder, and the other for disk storage on the 1541 Disk Drive.

CASSETTES AND THE DATASETTE RECORDER

What kind of cassettes will the Datasette use? It will use any kind of cassette that a simple audio cassette recorder will use. Naturally, some cassettes work better for data storage than others, and some offer much more value for their cost. Let's look at cassettes which work well with the Datasette.

BUYING CASSETTES

Our first order of business is buying cassettes. First of all, the Datasette is not set up to take advantage of the higher grade tapes used in audio recording, such as chromium-dioxide or metal-particle tape. Ferric-oxide tape works just fine; it's also cheaper. The second item to consider is that the Datasette packs a lot of information on a small amount of tape. Short-length cassettes work best for storing files.

So what's the best cassette for use with the Datasette? Try a C15 or C30 ferric-oxide tape. A C15 cassette gives you 7 1/2 minutes of recording time per side, and can store over 25,000 characters of data. Longer tapes work well, but you'll have to do a lot more

rewinding and fast forwarding to get to files stored on your cassette. There are leaderless cassettes manufactured specifically for computer use, but these are usually more expensive than audio cassettes, and not necessarily better.

MULTIPLE PROGRAM STORAGE ON CASSETTE

When you save information on a cassette, it's usually convenient to store just one file on each side. This way, there's no problem finding the beginning of your file. You just rewind the cassette to the beginning of the side, then load the file. If you'd like to save some money by putting several files on each side, you must use the tape counter on the Datasette. The tape counter is a small meter that tells you how much of the cassette you've played.

When you first put the cassette in to save a file, make sure it's rewound all the way to the beginning of the side. Press the small button next to the counter. This will reset the counter to 000. Now save the file. When the C64 is finished, and the Datasette has stopped, advance the tape at least 10 counts past the current counter reading. Write the new counter reading down, and you're ready to save another file. This way you can save many files on one side of a cassette. Just be sure to leave at least 10 counts between the end of one file and the beginning of the next, and to write down the counter reading and file name at the beginning of each file.

When you want to load a file from a cassette that has several files per side, first rewind the cassette all the way to the beginning of the side. Set the counter to 000, then fast forward the cassette to a counter reading a few counts before the counter reading where the desired file is stored. Follow normal loading procedures, and the computer should find your file for you and load it at your command.

Occasionally the counter will get off by a count or two, and the file won't load. If so, try starting the file load at an even lower counter reading to see if you can pick it up. If necessary, you can start from the beginning of the tape, loading every program on it to see where each program is located, and what it's named. If you enter the LOAD command by itself with no filename, the C64 will load the first program it encounters, and will tell you its name. Using LOAD several times in succession will take you through the entire tape. But even using these methods you may occasionally lose files to defective tapes.

One important fact to note is that tape counters vary from recorder to recorder. Therefore, you may have trouble finding a file stored in the middle of a cassette made on another machine.

DUPLICATING FILES

As you can see, cassettes are not always the most reliable of storage media. It's important to make duplicate copies of important files by saving them twice. This way, if one of your files is lost because of a faulty cassette or an error in saving it, you always have a

backup. Get into the habit of backing up every important file on two different cassettes.

Once you have two cassette copies, keep one rewound to the beginning of side 1, and the other rewound to the beginning of side 2. This way, you won't have to go through a lot of rewinding to get to a program on the opposite side of a cassette. Just use the cassette that's rewound to the side you want.

WRITE PROTECTING A CASSETTE

When you have important files that you absolutely do not want erased or recorded over, there is a way to *write protect* the cassette. Lay the cassette with the side you want protected facing up. Turn the cassette around so you can see the back. You'll see two small tabs. Break out the one on the right. The top side of the cassette is now write protected.

To write protect the other side, break out the other tab. You'll find that it's now impossible to record on the write-protected sides. You won't be able to press the RECORD key down on the recorder when you put the cassette in. If you change your mind and want to erase or record over a write-protected cassette, just put a piece of tape over the write protect tab socket. Now you can record on the cassette.

CARE OF YOUR CASSETTES

When you store your cassettes, be sure to keep them away from magnetic fields. Magnetism erases cassettes. Common sources of magnetic fields are your computer monitor and your telephone. Heat will also erase files. Leaving a cassette in a closed car on a hot sunny day may not only erase parts of your cassette, but may also melt the plastic casing.

In addition to physically protecting your cassettes, be sure to label them clearly so you know what files are on which cassette, and where. This is especially convenient for files stored in the middle of a cassette. Be sure to write down the filename just as you created it when you saved your file so the computer will be able to retrieve it correctly. Good cataloging will save you a lot of time and trouble.

RECORDER MAINTENANCE

Like any audio cassette recorder, your Datasette recorder needs some routine maintenance to keep it in peak condition. This maintenance is fairly simple, and can be done in a few minutes.

CLEANING THE HEADS

As you use your recorder, some of the ferric oxide on the cassette tape will rub off on the record and playback heads. Eventually this buildup will prevent recording and playback. You should clean the heads periodically. You'll need a cotton swab and some 95% denatured alcohol. Here's what to do:

1. Unplug the Datasette.
2. Press the EJECT key to open the cassette compartment.
3. Press the PLAY key to make the recording and playback heads come out.
4. Dip the swab in alcohol, then gently wipe the tape heads.
5. Wipe the pinch roller and rubber capstan wheel, rotating the capstan wheel with your fingers to make sure you get the whole wheel.
6. Clean out any cotton left over in the recorder.
7. Press STOP to retract the heads.

DEMAGNETIZING THE HEADS

Tape passing by the heads also imparts a small magnetic charge which can build up over time. This magnetism will also impair the record and playback quality of the recorder. To demagnetize the heads, you'll need a head demagnetizer, which you can buy at an audio or electronic store. Now:

1. Open the recorder and extend the heads as described above.
2. Plug in the demagnetizer and turn it on if it has a switch.
3. Pass the tip of the demagnetizer over each head a few times.
4. Slowly pull the demagnetizer away from the heads until you're a yard or two away.
5. Turn off the demagnetizer.

It is important to follow steps 4 and 5. If you turn off the demagnetizer close to the recorder heads, it will leave a magnetic charge.

Cleaning and demagnetizing the heads occasionally will keep your recorder in good shape and minimize file losses. There are a number of maintenance products on the market to make this even easier, but beware of cleaning cassettes: they are abrasive and will eventually wear out the heads.

DISKETTES AND THE 1541 DISK DRIVE

As a rule, file storage on disks is much more convenient and efficient than cassette storage. There are still several things to watch and take care of when using the disk drive.

BUYING DISKS

Once you have files to store on your disk drive, you'll need to buy some disks. There are many kinds

of disks available. Which ones work with the 1541? In a nutshell, the standard disk used on the 1541 is a 5 1/4 inch, single-sided, single-density, soft-sectored floppy diskette. This is quite a chunk of information! What does it all mean?

First of all, the 1541 uses floppy disks and not the hard disks that are used in hard disk drives. There are three sizes of floppy disks: the 8 inch floppy, the 5 1/4 inch floppy, and the 3 1/2 inch floppy (also called a micro-floppy). The only size that fits the 1541 is the 5 1/4 inch floppy, called a mini-floppy.

Soft-sectored is a term that describes the way the 1541 locates information stored on disk. Some drives use a hard-sectored disk. There are holes punched in the disk that the disk drive can read to tell how far the disk has rotated. The 1541 doesn't need these holes. It sets down magnetic signals on the disk that it can read later to determine disk position. This is soft-sectoring.

Single-density refers to the storage quality of the disk. Some disk drives store twice the amount of information on a disk as the 1541 does. Since the information must be packed twice as tightly to fit in the same area, a disk of high enough quality to store this information is called double-density. A single-density disk is of lower recording quality and is consequently cheaper. The 1541 will work fine with either single- or double-density disks. Since most disk manufacturers now only manufacture double-density quality disks, you probably won't have to worry about density.

The last choice for buying disks is choosing between single- and double-sided disks. The 1541 will use either one. The difference between the two is that single-sided diskettes (like the disk included with your 1541 drive) only record on one side while double-sided disks can be recorded on both sides. This gives you double the amount of storage with one disk. Needless to say, double-sided disks are more expensive than single-sided disks. Later in this section, we'll talk about how to make single-sided disks into double-sided disks with very little difficulty.

When you finally sally forth to the market to buy your disks, what should you look for in quality? Many disks have guarantees that range from a few years to a lifetime. Many also have reinforced hubs, which make the disk sturdier and give it a longer lifetime. Some disks are packaged in plastic library cases which you can use for storage later on, some come in cardboard boxes. Some include labels, others don't. In general, you should try to buy the sturdiest disks possible for your money, since a worn out disk means lost files. Unless you have a special disk storage holder, you might want to pay a little extra money for plastic cases, which are sturdy, convenient to use, and will protect your disks from minor catastrophes.

FORMATTING DISKS

Now that you have your disks, we must *format* them. As explained above, the 1541 drive uses a soft-sector system to find locations on the disk. A brand new blank disk will only confuse the drive hopelessly. Before the disk can be used, the 1541 must put down

magnetic signposts so it can find its way around later on. This process is called formatting. Let's try it out.

First we need a name for the disk, and a two character ID code. The name can be up to 16 characters long, and can use any characters except the double quote and the comma. The ID code, which will be magnetically imprinted in many different areas of the disk, is two characters long, and can use any characters except the comma and double quote. Let's use FIRST DISK as our disk name, and use D1 as our ID code. To format the disk enter:

```
OPEN 15,8,15

PRINT#15,"NEWØ:FIRST DISK,D1"
```

The 1541 will start formatting, beginning with a loud razz and continuing with some quiet chortling sounds. The red busy light will be on. After about a minute and a half, the red light will turn off, and the disk will be formatted. The name we chose will be stored in the disk's directory, and the ID code will be stored in various places throughout the disk for later disk identification.

How did these two commands work? The first one opened a file # 15 to the disk drive, which is device # 8, using channel # 15. The second one printed a string through channel 15 to the disk drive. In the string, we had NEW0 which asks disk drive # 0 (the first one you have hooked up) to format a disk. After the colon is the name you want to title the disk, and after the commas your two letter ID code. You really don't need to know most of this to format disks, just enter the commands as shown.

One important thing to realize is that once you open channel 15 with the OPEN command, if you try to open it again, you'll get a ?FILE OPEN ERROR message. You only need one OPEN statement each time you format disks. Another even more important aspect of formatting a disk is that *it erases everything on the disk!* Use it with care and only on new disks or disks you want erased completely.

THE DISK DIRECTORY

Each disk you format has a directory on it with the name and ID code of the disk, and a complete list of all the files it contains. There are times when it would be very handy to be able to read that directory, especially if you run across an unlabelled disk that you've completely forgotten about.

You can load the directory from the disk to your C64 just as you would a program. The name of the directory is $. To load it, enter:

```
LOAD "$",8
```

To read the directory, enter:

```
LIST
```

The directory should appear on your screen. On the top of the directory, after the number 0, is the name

of your disk in reverse characters, followed by your ID code. Under the disk name follow the names of the files contained on the disk. In front of each file name is a number that tells how many blocks of disk space it takes up. The bottom of the directory is a statement telling you how many more blocks of disk storage you have free to use. As with formatting, there is one very important thing to know about reading the directory: by LOADing and LISTing it, you erase whatever program is in your computer at the time. Be wary of checking the directory while you are in the middle of writing a program.

THE C-64 WEDGE

There is a much easier way to give your disk drive commands than the ways we have just learned. It involves using a program called the C-64 Wedge, which comes on the Test/Demo disk included with your 1541 disk drive. The Test/Demo disk includes many useful programs which will help you copy files between disk drives, check your printer, show you some interesting ways of programming using the disk drive, and do other handy things. You can see them by loading the directory and listing it on your screen.

If you enter:

```
LOAD "C64-WEDGE",8

RUN
```

the C-64 Wedge will load into your computer, display a title message, and then erase itself from the BASIC program memory of the C-64. It leaves behind a small machine language program which remains in effect without getting in the way while you speak to your computer in BASIC.

The Wedge greatly simplifies disk drive commands when it is loaded and working. Here is a quick summary of some of the most useful commands.

For loading a file use:

```
/FILENAME
```

The " / " takes the place of the LOAD command, and FILENAME can be the name of any file you want. Notice that no quotes are needed.

For the disk directory use:

```
@$
```

or

```
>$
```

Either of these commands will print the directory on the monitor screen without erasing any program already in the memory.

For formatting a disk:

```
@NEW0:DISKNAME,ID
```

This simple format command allows you to format a disk without either having to open any channels or to use the PRINT command. Notice that there are no quotes and that DISKNAME can be any name you choose. Also, ID can be any ID code.

WRITE PROTECTING DISKS

We found out that when you format a disk, everything on it is erased. It's also possible to lose files through carelessness while saving other files to disk. If we have something very important on a disk and want to be absolutely safe, we can *write protect* the disk so that it will be impossible to format or write anything new on it. When you insert a disk into the drive, you'll notice a notch in the left-hand side of the sleeve of the diskette. This is the write-protect notch for the side of the diskette you are loading.

When the disk is in the drive, a beam of light shines where the notch is, and if it passes through, then the drive is allowed to write on the disk. If the beam of light does not pass through the notch, no writing or formatting is allowed.

To write protect the disk, take a write-protect tab, which should be furnished with your disk, and wrap it around the notch. If you don't have tabs, you can use a piece of black tape or anything that will block the light passing through the notch. Your disk is now safe. If you want to write to your disk again, simply remove the tab from the disk.

CONVERTING SINGLE-SIDED DISKS TO DOUBLE

When disks are manufactured, each side is checked for recording accuracy. If one side does not measure up, then only the good side is used, and it becomes a single-sided disk. In most cases, the bad side is still quite usable by the 1541 disk drive. The only reason that the back side can't be used is that there is no write-protect notch for it.

If you take a paper hole punch and punch a notch on the opposite side of the sleeve from the original notch, you can then use the back side of the disk. Be sure the second notch is located at exactly the same position on its side of the sleeve as the original notch is on its side. Otherwise, the notch light won't find it, and won't allow you to use the back side.

A couple of important things to note: Any warranty on your disk will certainly be voided. Also, the back side is not as dependable as the certified front side. You will know if the back side works if you can format it. If you can't format it, then it's a bad side and can't be used.

STORING AND PROTECTING DISKETTES

Like cassettes, disks are prone to damage from outside forces. Keep them away from magnetic sources such as your monitor, or you risk file erasure. Extreme heat can also erase files, so avoid leaving disks in a hot

car. Moisture can ruin a disk, and touching the exposed area of the disk through the head reading holes can ruin files with fingerprints. Never bend the disk; it will keep it from spinning freely. Always keep the disks stored in its jacket, and try to keep it in a case or file, away from dust and dirt.

MAINTAINING THE DISK DRIVE

The disk drive has a recording head like a tape recorder, which needs to be maintained in a similar manner. Dirt, dust, and ferric oxide from the disk can build up on the head and diminish its recording capabilities. It can also build up a magnetic charge over time. The head needs to be periodically cleaned and demagnetized.

Unlike a tape recorder, the head is located deep inside the machine, where it can be hard to get at. Some people prefer to take their disk drive in to a service center to have it cleaned and demagnetized. Others do it themselves, either by taking the drive apart and cleaning the head by hand, or by using a cleaning disk.

6. PERIPHERALS

As you get to know the capabilities of your C64 and become more proficient in using it, you'll also become more aware of the things you wish it could do that it can't. Never fear! It's easy to add peripherals to your computer system that will change it into a truly powerful tool. There is an amazing variety of add-ons built by Commodore and other companies, and we'll take a look at what's available in this chapter.

Before you go out to spend money indiscriminately on hardware for your C64, take some time to consider your purchases. Answering satisfactorily the four questions below will help you avoid buying a peripheral that collects dust later.

Does the peripheral do what you want it to do? The Samurai Remote Control Sabrelight Joystick may turn your computer system on and off from a distance of 30 meters and cauterize video wounds, but if it doesn't give you the right control over your favorite version of Space Death, it may seem worse than useless to you. Be very specific about what you want a peripheral to do before you start shopping.

Is the peripheral compatible with your computer system? Make sure first of all that it will run with a Commodore 64 computer. Then make sure you have the necessary memory needed to support the peripheral. Some peripherals also need extra connecting cables and equipment before you can attach them. Be sure they are available.

Can you buy or write software to run the peripheral? Unless your C64 has a program telling it how to give orders to this strange piece of hardware, it won't be able to do a thing. Some hardware manufacturers sell software with their peripheral, others let you write your own (if you have enough information) or let you

find it on the market. Just make sure you can supply it somehow, or your peripheral will just sit there and make you feel foolish.

Is there a clear owner's manual or a knowledgeable person around to make sure you know how to operate the peripheral? Never forget that most computer equipment is more than a little complex; it needs good clear instructions to be properly operated. If you have a knowledgeable friend or salesperson around, fine. If not, make sure you take a look at the manual before you buy.

Once you've settled on a good peripheral, you have two major options for buying it—mail order discount stores and retail computer stores. The advantage of the mail order discount business is obvious: very low prices. Unfortunately, at these low prices they can't really afford to give you much service or advice. Mail order works best when you know you won't have problems operating what you buy.

Now we'll examine some of the types of peripherals available for use with the Commodore 64 computer. They range from popular hardware such as printers and modems to the more esoteric items such as EPROM programmers. The microcomputer industry is changing constantly, so be on the lookout for new peripherals not mentioned here, or newer versions of standard hardware with more features or a lower price.

PRINTERS

Adding a printer to your computer gives it the ability to create *hard copy*—print that won't disappear the moment you switch off your computer. A good printer can print out listings of your programs, letters to friends or business associates, mailing labels, manuscripts, and many other documents. It's one of the most useful peripherals available. Since there is a large selection of printers which will work with the C64, it's very important to know what you want your printer to be able to do before you buy it.

One of the first things to consider is character quality. How does the printer form the characters that it prints on paper? Most computer printers are *dot matrix* printers. Dot matrix characters are formed by a small comb of pins which sweeps across the paper for each line of print. The pins hammer against an inked ribbon in the correct combination to create whatever kind of character is desired. The more pins there are, the more complex and well-formed the characters can be. Although dot matrix print does not look as nice as typewritten text, it's much faster, and usually offers a choice of different character styles called *fonts*, such as pica, elite, boldface, and elongated. Quality of print changes quite a bit from printer to printer, and usually varies according to price.

A cheaper form of dot matrix printer is called the *thermal* printer. The thermal printer uses specially coated paper, and prints by using hot pins that burn the characters into the chemical coating instead of hammering them on with a ribbon. The disadvantage of the thermal printer is that it must use special paper, and the print quality is not usually good. However, it is much quieter than any other kind of printer.

For high quality print, most people use a *letter quality* printer. The letter quality printer creates letters the same way that a typewriter does—it hammers the characters on the paper using a ribbon and a set of fully-formed metal characters. While it's possible to actually hook up an electric typewriter to the C64 (with considerable difficulty unless the typewriter is specially designed for a computer interface), it's usually preferable to use a *daisy wheel* printer. The daisy wheel printer has a small rotating wheel (the daisy wheel) with many flexible hubs. Each of the hubs ends with a metal character which strikes ribbon paper to print a character. A daisy wheel printer prints much faster than a typewriter, but with equivalent print quality. You can change fonts by physically changing the daisy wheel. A letter quality printer's high print quality is offset by its slow speed and high noise output. Many of them are also quite expensive, but some recent models have been quite reasonably priced.

There are several other things to consider when buying a printer.

Is it *bidirectional* (able to print across the page from right to left as well as left to right)? Bidirectional printers are faster then unidirectional printers.

Is it a 40-column, 80-column, or 130-column printer? It usually takes 80 columns to fill an average 8 1/2 x 11 inch piece of paper. Forty-column printers are usually used to print on a small roll of adding machine paper; 130-column printers can print on extra wide financial forms.

Does it have friction feed, tractor feed, or both? Tractor feed uses toothed gears or belts to feed fanfold paper (special computer printer paper) through the printer without you worrying about putting each page in separately. Friction feed lets you put in individual sheets of paper, such as letterhead stationery.

How big is its *buffer*? Your C64 feeds text to the printer very quickly. The printer uses it very slowly, which forces your computer to wait. A buffer is memory in the printer which stores the text from the computer and feeds it to the print head. The larger the buffer is, the sooner your computer can finish feeding text to the printer so you can use it again.

Is it capable of graphics? In other words, if it's a dot matrix printer, can you control each individual dot printed to create detailed pictures instead of characters?

When you shop for a printer, you'll have many choices. Commodore makes several printers which are designed to hook up directly to the C64 and which will print out the special graphics characters available on your keyboard. Other companies produce printers with special features or quality that you may want. Keep in mind that you'll usually need a special cable or interface to connect these printers to your C64. Since the Commodore 64 is becoming a very popular computer, you'll probably be able to find the necessary cable without too much trouble.

MODEMS

A modem will connect your computer to the phone lines and other computers, so you can send and receive data quickly over long distances. With a modem, you

can access the large banks of information stored in computer networks such as airline schedules, stock reports, late breaking news reports, and much more.

Like printers, modems come in many varieties. One of the first considerations a modem buyer must make is that of speed. How quickly can the modem send and receive data over the phone lines? Data transfer speed is measured in bits per second (bps). Most modems used with microcomputers are capable of 300 bps, which would let you send one screenful of text over the phone lines in about a minute and a half. Twelve-hundred bps modems are becoming more common now, and will quadruple your data transfer speed. Many modem makers refer to "baud rate" in describing their equipment. The baud rate measures the frequency of the signal that carries the data. Sometimes the baud rate is equal to the bps capability of a modem, but sometimes it isn't. For instance, most 1200 bps modems use a 600 baud signal for transmitting data. Always look at the bps measurement to determine data transmission speed.

Modems can transmit data in *full duplex* or *half duplex*. Full duplex transmission allows the modem to send and receive data at the same time, similar to a telephone conversation where you can listen and speak simultaneously. Half-duplex transmission forces two computers to take turns sending and receiving data, much like a conversation over a two-way radio. Full duplex is most common in microcomputer modems.

Another important consideration is whether the modem is *direct- connect* or *acoustic*. An acoustic modem requires you to place the handset of a telephone into a cradle lined with foam rubber, where data is changed into sound to be fed into the telephone mouthpiece. The direct-connect modem does away with the need for a telephone by plugging directly into a telephone jack and sending electric signals over the phone wires. Direct-connect modems are much more reliable than acoustic modems.

Many modems are "intelligent." This means they contain their own microprocessor and software which allow the modem to perform many tasks by itself with only a prompt from your C64. An intelligent modem might be able to read incoming data, determine the data transmission rate, and set its own rate accordingly. It might also be able to automatically dial phone numbers using touch tone or rotary dial signals, answer incoming phone calls, and hang up when through. These capabilities allow you to set up very sophisticated automated data exchange procedures if you wish.

Modems come with many different features and price tags. As with printers, you'll probably need a special cable to hook one up to your C64. Commodore makes two different modems which will connect directly to the back of your C64. You will also need some software to run the modem, which will be discussed in Chapter 7.

INTERFACES AND CABLES

Unlike a stereo system, cables connecting computers and their peripherals are usually quite complex and somewhat costly. These cables are made specifi-

cally for certain peripherals and brands, and are not usually interchangeable. There are some standards to peripheral connections (called *interfaces*), and they are worth knowing about.

The RS232C interface is a *serial* interface, meaning that it sends data over one line, one bit after another. RS232C is the name of a standard method of sending the data, and a standard configuration of wires which control the data transfer. Many peripherals, such as modems, use the RS232C interface. The C64 has an RS232C port in the back, but the voltages it uses are not quite at the RS232C standard, so connecting an RS232C compatible peripheral may need a special adapting cable.

IEEE is a standard *parallel* interface, which sends data over 8 lines simultaneously. It's quite often used to connect disk drives and other peripherals requiring fast data transfer to a computer. You can buy an IEEE adapter for your computer, which allows you to connect larger disk drives to your C64.

Several companies manufacture special *universal* printer interfaces which allow you to connect most printers directly to the C64. There are also universal cassette interfaces, which let you use cassette recorders other than the Commodore Datasette recorder for data storage.

IMPROVING YOUR CURRENT SYSTEM

Printers and modems are additions to your Commodore 64 system. Many products are made to improve and expand the capabilities of equipment you may already own. Let's take a look.

THE COMPUTER MONITOR

Most people who buy a home computer use their television set as a monitor, since it saves them the cost of buying a new peripheral. A TV set is not often the ideal monitor, however. The picture quality is not as clear as it might be, and text can be difficult to read. If someone is using a hair blower or a vacuum cleaner, or if your printer is turned on, the TV set will usually pick up static and interference. A computer monitor can solve these problems.

Computer monitors, which are specially designed for use with computers, present a much clearer picture than a TV set. They connect directly to the computer without the use of a junction box and use a much wider bandwidth to send a much clearer picture. They come in two basic types: the color monitor and the monochromatic monitor.

A color monitor looks and works like a color television set without a channel selector. A typical monitor has a 13-inch screen, knobs controlling the color, tint, brightness, contrast, and vertical hold, and a speaker with a volume control. Some monitors don't have a speaker. If you use one of these, you can easily hook up a separate speaker or feed the audio signal to your stereo system.

Monochromatic monitors usually display just green or amber against a black background. The chief advantage of a monochromatic monitor is that it can display text and fine lines with much more clarity than a color monitor. A monochromatic monitor is much less apt to create eyestrain than a color monitor. For these reasons, they are usually used for word processing purposes.

Commodore makes an excellent color monitor which works with the C64. There are many other monitors available through other companies which also work with the C64. Just be sure to use a monitor which takes a composite video signal, the kind the C64 sends out. RGB type monitors will not work with the C64.

DISK DRIVES

Disk drives are fast and efficient. Floppy disks are the most common medium for commercial software, and many tasks, such as word processing and data base management, are virtually impossible without a disk drive. If you have only cassette file storage, a disk drive should be your first upgrade. If you're a glutton for mass file storage, you can connect up to five disk drives to the Commodore 64, although two seems to be the optimum number.

Commodore makes the 1541 disk drive specifically for use with the Commodore 64 and VIC computers. An earlier disk drive model, the 1540, can also be used with the C64 if it is updated at a Commodore service center. Commodore also makes dual disk drives, which will accept two disks simultaneously, and other heavy duty drives which can be connected to the C64 using an IEEE interface. Other companies are also making disk drives for the C64 which should be very competitive in price and features with the 1541.

For truly large memory storage, you can buy a hard disk drive. The most common hard disk drive used with microcomputers is a type called the Winchester drive, manufactured by several different companies. The Winchester disk drive uses a stainless steel disk to store data on. This disk is usually factory installed, and not removable, although newer models may feature removable disk packs. The average Winchester disk stores 6 to 20 megabytes (million bytes)! This is 35 to 125 times the storage capacity of a single-density floppy disk. Winchester drives are for the serious user: they are likely to cost at least 7 or 8 times as much as your C64.

80-COLUMN BOARDS

When you use the C64 to arrange text for printout on a printer, you'll run across a problem. You can only display 40 characters across the width of the monitor, while a good printer will usually print 80 columns across an 8 1/2 by 11-inch paper. Adding an 80-column board to your computer will let it display 80 characters across the monitor.

One problem with an 80-column display is that a home television set does not have a fine enough resolution to display the diminished 80-column characters.

Even color monitors will have some difficulty with characters this small. If you plan to use an 80-column board, you should have a monochromatic monitor in use as your display.

ADDITIONAL PERIPHERALS

There are many other peripherals available for the Commodore 64 which are useful or entertaining to use. Some might seem silly or frivolous, while others might be just the thing you were looking for.

GAME CONTROLLERS

The Commodore 64 is an excellent game machine as well as a powerful computer. There are two game controller ports on the right side which will take a variety of controllers. Commodore manufactures joysticks and paddle controllers, which are the most commonly used game controllers. Since the game controller ports are compatible with game controllers used with Atari computers and home video games, there is a large assortment of game controllers available. Video game connoisseurs might wish to use fancy joysticks to give them the real feel of the arcade games. Remote control joysticks are available for the wandering player, and trackballs, used in arcade games like Missile Command, are also available for games that use them.

LIGHT PENS

A light pen looks much like its name: it is a slender metal tube attached to a joystick port. When you press a light pen to the screen, the computer can tell its location. When used with the appropriate software, it can draw pictures directly on the screen, select options from a screen-printed menu, erase, and perform many other functions. Independent manufacturers offer light pens with different options: switches that activate when the pen is pressed against the screen, and high resolution pens.

PLOTTERS

A plotter creates letters and pictures on paper much as a printer does. The big difference is the way that it creates them. A printer might use the dots of a printing comb or a daisywheel; the plotter actually draws using a pen on the paper. Plotters usually hold the sheet of paper on a paper bed and draw figures with fine felt tip pens. A plotter can usually use two or three different color pens, and the more expensive models can use up to six or seven pens. Aside from the colors available, the chief advantage of a plotter over a dot matrix printer capable of graphics is that the plotter draws very smooth lines and circles without the "computer look" that dot matrix leaves. Commodore makes a combination plotter/printer which runs paper through on a rubber cylinder instead of holding it on a paper

bed. It uses four color pens and can create bar charts and graphs as well as alphanumeric characters.

CHRONOGRAPHS

A chronograph keeps a running account of the time, even while the computer is off, by using battery power. It usually uses quartz control and is very accurate. The primary use of a chronograph is to control automatic computer functions which musttake place at a certain time of day. If you have ingeniously wired your home burglar alarm system into your computer, using a chronograph lets you turn it on and off on specific days, hours, and minutes of your choosing. Perhaps the most common application is to use it in conjunction with a modem to send and receive data from other computers or computer networks when you aren't around to control things.

EPROM PROGRAMMERS

EPROM is an acronym for Erasable Programmmable Read Only Memory. An EPROM chip can be used to store your own programs, and can be plugged into a circuit board to create your own program cartridges. EPROMs are generally used only by advance programmers. To store a program on an EPROM, you need an EPROM programmer, which connects to your C64 and reads the program you want stored. It transfers the program to the EPROM, and voila! Your program is etched in microcircuitry.

WARNING:

Just when you think you know what all the peripherals are about, some new and totally incomprehensible piece of hardware will pop up to confound you. Read the computer magazines and keep abreast of current developments.

7. SOFTWARE: RUNNING YOUR COMPUTER

Without software you can do nothing to your computer system but turn it on and off. You need programs to run your computer, to tell it what to do. If you can program, you can write your own software. However, many computer owners either are not programmers, or don't have the time to spend writing programs. Even expert programmers don't have the time to create software for everything they'd like their computer to do.

Fortunately, there is a large variety of software for sale for the Commodore 64. A glance through a computer magazine will reveal more software than most people would care to consider. There is software to

keep your finances up to date, to teach the kids math, to play cards with you, to run your printer, to draw pictures on your monitor, and on and on. New software is continually being written and marketed.

To make some sort of sense out of this rampant software, let's split it into four categories:

- Applications software
- Utility software
- Computer languages
- Games

Briefly, applications software is software written to perform a specific task for you, such as word processing, data base management, bookkeeping, and education. Utility software is designed to make operating your computer easier. There are utilities to help you design monitor graphics and get music from your C64. Computer languages offer you different methods of programming, and games are just that: entertainment.

Just as with hardware, when shopping for software it's very important to make sure it will work for *you*. Consider the following questions when buying.

Is the program compatible with your system? Make sure it's written for a C64 computer, and comes on a medium you can load in your system (such as cartridge, cassette, or disk). Make sure you have the necessary peripherals to make it work. For instance, a telecommunications program requires a modem.

Is the program easy to use? Difficult or "user-unfriendly" programs are sometimes self-defeating. For instance, a bookkeeping program which is very confusing may not save you any time over using pencil and paper.

Is the program versatile? A good program should give you many options and should be flexible enough to be used for your particular needs. In a game program, this might mean varying difficulty levels to keep the challenge up. In a data base program, it might mean being able to tailor your record format so you can enter the information most important to you. It's important to realize that versatility and ease of use often conflict with each other. You need to decide which is most important to you.

Will you get repeated good use of the program? This is especially important in game software, where boredom can set in long before you've gotten the value of your purchase price from it.

Does the software company offer a good backup and replacement policy? Unfortunately, disks and cassettes do wear out, and if they do, the software you paid for is gone. Some companies give you "unprotected" software, which means you can copy it yourself to create a backup for use in case of disaster. Most companies "protect" their software, making it impossible for you to duplicate. They do this to foil "pirating" (duplicating copyrighted software to give away or sell). Most companies who protect their software will replace failed disks or cassettes for a low price ($5.00 or less), and some will give you a second copy for use as a backup.

APPLICATIONS

Application software for the C64 falls into several general categories which are covered briefly below.

WORD PROCESSING

Word processing is one of the most useful applications of a home computer, and can save you a lot of time and effort if you do any kind of writing or typing. Many people who initially disdain computers are eventually won over by the convenience of word processing. It lets you write all of your text on the monitor screen and store it in RAM before having it printed out on paper. Since the text is stored on a very volatile medium, it's very easy to correct and edit. A push of a button will print out your text on a printer, and you can then store your text on disk for later re-use.

There is tremendous variety in word processing programs, and many users become ardent advocates of one program or another. Some of the features available in good word processing programs are discussed below.

Text insertion is the ability to insert new words or characters in the middle of previously created text. The computer will take care of the text following the insertion by moving it down as new text is entered.

Text deletion allows you to take out single characters, and small or large blocks of text. Once again, the computer will shunt into place the text following the deletion so there is no gap in your text. Since mistaken deletion of large blocks of text can be disastrous, some programs have a failsafe feature which stores what you have deleted in a *buffer*, which is a separate area in RAM. By giving the appropriate command, you can reinsert the lost text in the position you wish.

Text movement is the ability to move a block of text from one area of your manuscript to another. This is a combination of text deletion and insertion, which allows you to move one paragraph over another one, or interchange sentences for a more convenient order.

Global search and replace is a powerful editing feature which will search through the text you have already entered for any word or combination of words you would like to search for, and replace them with any other word or words of your choice. If you want to reuse a letter you wrote to Mr. Jones to send to Ms. Smith, you can have the computer change every occurence of Mr. Jones to Ms. Smith.

Print formatting is quite different from the previously discussed word processing features that let you order and correct your text as you wish but have nothing to do with actually printing it out on paper. Print formatting does let you choose how your text will look on the printed page.

There are many aspects to print formatting. Font selection lets you use the different fonts that might be available on your printer so that you can italicize or use boldface for emphasis and use expanded characters for titles. Right justification evens the right margin of your text, and two-column printing will let you print in two columns on a sheet of paper, both of them right-

justified. Text centering will center selected text in a page without you having to calculate how far to indent it.

Many word processing programs will automatically number pages of a manuscript, and print headers and footers (a common expression on the top or bottom of each page). Very fancy programs may even do footnotes.

Print previewing allows you to see how the page will be laid out before it's printed. This is quite a trick on the C64, since it's limited to 40 columns and 25 lines. Most print previews will let you look at a section of a page at a time to see the margins, indentations, headers, and footers. If you can find a program that works with an 80-column board, then print previewing is simplified, but still not entirely complete.

When you decide on a word processing program, the most important question to answer should be: how much work and time do you save using it? The commands should be easy to use and remember, and moving the cursor around the screen for editing should be easy. Another important consideration is that it must be written so that it will work with your particular model of printer. Try them out before buying.

DATA BASE PROGRAMS

A data base program lets you use your computer memory and disk storage as a very fast and efficient filing system. The information you store is called the *data base*, and the data base program is designed to reorder and recall the data base at your commands. For instance, you might wish to keep a list of all the books you own. First, you would create a *file* with the program, perhaps called BOOKS, to hold your data base. Then you would decide what information was important to know about books. The information about each book would be called a *record*, and each record would contain your specific information in separate parts called *fields*. Each record in your BOOKS file might have three fields: one for the title, one for the author, and one for the subject of the book. Once you have entered all of your books in the BOOKS file, you'll have one record for each book. The data base program will store the records on disk and keep track of their location.

The real power of a data base program comes in handling the data base once it's entered. It can automatically put the records in alphabetical or numeric order using any field you wish. For instance, you might have it arrange all of your book records in alphabetical order by author. It can search through the data base to find any record using any field. You might have it show you each book record for book titles between B and F. The program is very powerful when you can search records using several fields at once. This lets you look for all books about octopi written by Ed Cephalopod.

The data base program should be able to generate lists and reports using a connected printer. This allows you to print out your entire data base in any order you want, or just selected portions of it. It will also let you choose just which fields of the records you want printed, and in what order. Some data base programs will total

up numerical fields at the end of a printout, which comes in very handy when storing income tax or other financial records. Other data base programs can be used with word processing programs to create form letters with personalized touches.

When buying a data base program, you should know what information you need to store, and how much capacity you need. There are simple and inexpensive programs that are just right for recipe files that would be disastrous for keeping track of tax records or personnel reports. Print-out capabilities are also very important if you plan to generate inventory reports or similar documents.

FINANCIAL PROGRAMS

Many financial programs available might be thought of as specialized data base programs with calculating capabilities. Some are extremely simple and might help you keep track of home expenses or balance your checkbook. Other very powerful and specialized programs and have been written for specific business applications such as payroll or inventory control.

If you buy a financial program for a specific business application, you should realize that it has probably been written for a general purpose so that it will be marketable. But what works for the general market may not be quite what you had in mind for your specific application. It is especially important to try out business programs or to read their manuals thoroughly before you buy them. Make sure that they'll do what you need to avoid wasting money on the high price that these programs can cost.

SPREADSHEETS

A spreadsheet program is the computer equivalent of a large sheet of paper, a pencil, and a powerful calculator. It's extremely useful for complex calculations, business projections, and general figuring. The original spreadsheet program, *Visicalc*, is so popular that many businessmen have bought microcomputers just to be able to use it.

A spreadsheet allows you to do your calculations on a large electronic worksheet. Your monitor acts as a window on the worksheet, which is much larger than the monitor. The worksheet has many columns and rows, and you can enter figures, labels, or formulas at each location (known as a *cell*). The true power of a spreadsheet is the ability to define a cell as the result of calculations using other cells; when you change the value of any one cell on the spreadsheet, all other cells dependent on that position will change their value automatically. This extremely powerful feature allows you to use the spreadsheet for projections and "what if. . . " calculations. For instance, you might enter a series of products for sale with the individual prices, projected sales for the upcoming year, and sales totals. When you raise or lower the price of a single product, the projected sales totals will all be changed automatically.

At this printing, *Visicalc* itself is not available on the Commodore 64, but there are many other pro-

grams with comparable features available. Some features to check are total worksheet capacity, printout capabilities, and ease of use.

EDUCATION

Education programs, once used as a rationale for buying a home computer actually used mostly for game playing, are finally coming into their own. Boring and overly simple programs are now being shoved out of the marketplace by programs which educate by stimulating interest and creativity. For convenience, we will categorize education programs as drill, simulations, or study courses.

Drill programs are usually used to teach children a fundamental concept using repetitive exercises for them to practice with. This need not be as dreary as it sounds. Many educational programs are written to make the learning fun, and are often some type of game with rewards and fancy graphic displays for correct answers. Typical topics covered are multiplication and division, spelling, geography, shape recognition, typing, and speed reading for advanced readers. There are drill programs for all ages, from toddler to adult, which provide a good way to teach fundamentals as well as to make the user more comfortable with computers.

Simulations can teach complex subjects by presenting a situation on a screen that the user must react to in a knowledgeable way. A good simulation can put the user in situations demanding assessment, planning, and decision-making. For example, a simulation may put the user in command of a wagon train on the Oregon trail with a limited supply of food, ammunition, farming equipment, and time. With each passing day, the computer demands decisions regarding direction of the wagon train, distance traveled, and amount of food consumed. Wrong decisions may result in extreme discomfort or death. It becomes obvious that the big advantage of a simulation is the chance to learn by doing without having to live (or die!) with your mistakes.

Study courses essentially use the computer to make an audio-visual presentation of a subject. Foreign languages make good study course subjects, since words and pictures can be presented together on the monitor to reinforce vocabulary retention. Other study courses can present fundamentals of electronics, car repair, or BASIC programming.

TELECOMMUNICATIONS

If you own a modem, you'll need telecommunication software to run it. A good program will let you set the rate and manner of information exchange so that you can match your computer with the telecommunication standards of others. It will also display incoming text in an easily readable manner and store it in memory as well so you can read it after you have stopped communications. Telecommunication programs come with varying features for beginning and advanced uses.

UTILITIES

Utilities aren't written to accomplish any particular task; they are instead meant to help you get better use of your computer by making its features easier to use.

BASIC UTILITIES

Many utility programs make programming in BASIC easier or more efficient. Some of them are actually new or expanded versions of the BASIC included with your C64. Expanded versions of BASIC will add new commands for your use, which may make programming graphics, sounds, and input/output to external devices much simpler.

Another tool for BASIC programming is a BASIC compiler. Each time you run a BASIC program, every command stored in it is first interpreted into machine language and then executed. A compiler takes a BASIC program, turns it all into machine language, and then stores it. The program can now run many times faster than it did in its BASIC form, since it no longer needs to be interpreted.

CP/M

CP/M is an operating system designed by Digital Research, Inc. for computers with Z-80 microprocessors. There is a large body of software written for use with the CP/M operating system, much of it business programs. Since the Commodore 64 uses a 6510 microprocessor, it can't run CP/M software by itself.

Commodore makes a Z-80 microprocessor card that plugs into the rear of the C64. This card lets you disable the 6510 microprocessor, put the Z-80 in charge of the computer, and run CP/M software. The card comes with a disk containing the CP/M operating system which must be loaded after installing the card.

GRAPHICS SOFTWARE

The C64 offers fine graphics capabilities; it can create pictures in color and in great detail. It's also capable of sophisticated animation using a special feature called *sprites*. Unfortunately, the version of BASIC included with the C64 does not make using these features very easy.

There are many software packages available to help you work around BASIC 2.0 to get the best use of your graphics capabilities. Some programs help you design sprites and move them around the screen. Others act as drawing devices to let you use the monitor screen as a sophisticated sketch pad. Some of these may make use of a light pen or joystick. A third kind of graphics software lets you design screens to contain mixtures of graphics and printing, and some will even let you redesign the characters that appear on the screen, so that you can use Cyrillic, Greek, or any character set you wish to design.

MUSIC SOFTWARE

The SID chip in your C64 is a surprisingly sophisticated digital music synthesizer which can produce three voices of music simultaneously. It can also produce sounds of wide tonal variety and can be used to imitate many acoustic instruments. Unfortunately, using SID with BASIC requires using a lot of numbers to control these features. Music software gives you much more immediate control over your computer, using music staffs, joysticks, and other devices to enter the notes, pitches, and timbres you desire.

COMPUTER LANGUAGES

The C64 is a multilingual computer—that is, it can use many different computer languages for you to do your programming. The standard language, of course, is BASIC 2.0, but there's a variety of other languages available for your specific programming needs.

LOGO AND PILOT

LOGO and PILOT are two languages used primarily for education. LOGO makes use of a command structure that makes it very easy for young children to learn the essentials of programming, and PILOT is essentially a simplified version of BASIC. Both languages contain some powerful graphics commands which make it easy for children and educators to create colorful pictures.

ASSEMBLY LANGUAGE

Assembly language is a tool for experienced programmers to write their own machine language programs. It uses simple commands called *mnemonics* which are interpreted directly into machine language equivalents, allowing the programmer to write very fast and efficient machine language programs.

FORTH

Forth combines the speed and efficiency of machine language programming with the ease of a higher level language such as BASIC. It comes with a list of commands called a *dictionary*, which can be used by the programmer to create his own commands. These customized commands, which can be stored on disk, eventually make Forth a language tailor-made for its user.

GAMES

Gaming and computers have gone hand in hand as long as both have been around. Specialized game computers such as the Atari 2600 and Mattel Intellivision have outsold home computers in the past. The

advanced features and expanded memory of the Commodore 64 make it capable of much more sophisticated games than you will find on a home video game system.

ARCADE GAMES

Arcade games essentially duplicate the fast action and sophisticated graphics found in a video arcade. They require a quick eye and fast reflexes and are shamefully addictive. Most arcade games are usually shoot'em up games, where you control the firing motion with a joystick, although more recent games have come out with refreshingly new formats, such as maze chases, rescue missions, and other similar endeavors. The incredible variety and number of arcade games available ensures as much action as your video budget can support.

STRATEGY GAMES

Strategy games are usually adapted from popular board or card games. A home computer is very good at dice shaking, minding a bank, checking for rule infractions, and other tedious tasks. If you can't find other players, the computer will play against you, sometimes too capably. There are versions of popular board games such as chess, checkers, and backgammon, and of card games like cribbage, bridge, blackjack, and poker. Simulated war games also work very well on home computers.

ADVENTURE GAMES

Adventure gaming is an exclusive genre of the computer. You control the central character, telling him, her, or it where to move, what to look at, what to pick up, and what to say. Many adventure games are presented entirely in text, which, as you move from location to location, describes your surroundings to you. Others show your surroundings in vivid video graphics. Usually you have a goal to accomplish: a rescue, treasure to find, or merely staying alive. Many excellent adventure games have been translated from versions for other computers and are now available for the C64.

APPENDIX A: HARDWARE AVAILABLE FOR THE C64

This chart is a list of hardware available for the Commodore 64 computer. It is by no means a comprehensive list. In fact, there are so many printers, modems, and other peripherals on the market that will work with the Commodore 64 that a full list is beyond the scope of this Handy Guide. Hardware is listed here either because it was made especially for the C64 or because it is somewhat rare and hard to find. Check a current edition of a home computer magazine for current prices and availability.

PRINTERS

1525 Printer, Commodore Business Machines
1526 Printer, Commodore Business Machines
1520 Printer Plotter, Commodore Business Machines

MODEMS

1600 Modem, Commodore Business Machines
1650 Automatic Modem, Commodore Business Machines

COMPUTER MONITOR

1701 Monitor, Commodore Business Machines

DISK DRIVE

VIC 1541 Single Disk Drive, Commodore Business Machines

80-COLUMN BOARD

Video-Pak 80, Data 20 Corporation

LIGHT PENS

The Light Pen, Programmer's Institute
LP-10 Light Pen, Tech-Sketch, Inc.
LP-15 Light Pen, Tech-Sketch, Inc.

EPROM PROGRAMMERS

Several models available from Optimal Technology, Inc.

EXPANDER BOARD

CBM64 Expander Board, Precision Technology, Inc.

PRINTER INTERFACES

Smart ASCII, Midwest Micro, Inc.
Universal Parallel Printer Cable and Driver, Micro-Ware Distributing, Inc.
The Connection, Micro-Ware Distributing, Inc.

CASSETTE MACHINE INTERFACES

Universal Tape Interface and Duplicator, Micro-Ware Distributing, Inc.
CBM 64 Rabbit Cartridge, Eastern House

IEEE INTERFACE

IEEE Interface, MSD, Inc.

APPENDIX B: APPLICATIONS, UTILITIES, AND LANGUAGES AVAILABLE FOR THE C64

The following is a list of some of the software available for the C64. It concentrates on applications, utilities, and languages. It entirely avoids games, which are too numerous to list and are probably the most easily found software. Check a current edition of a home computer magazine for current prices and availability.

APPLICATIONS

WORD PROCESSING

WordPro 3 Plus/64, Professional Software, Inc.
HESWriter, HesWare
Busiwriter, Skyles Electric Works
Easy Script, Commodore Business Machines
Totl.Text, Totl Software, Inc.
Word/Name Machine, Commodore Business Machines
Paper Clip, Batteries Included
The Writer's Assistant, Rainbow Computer Corporation
Quick Brown Fox, Quick Brown Fox

DATA BASE PROGRAMS

Research Assistant, Totl Software, Inc.
Mini Jini, Jini Micro-Systems, Inc.
The Manager, Commodore Business Machines
The Filing Assistant, Rainbow Computer Corporation
The Recipe Box, Aries Marketing Co.
Home Inventory, Creative Software

FINANCIAL PROGRAMS

The Color Accountant, Programmer's Institute
Easy Finance I, II, III, IV, and V, Commodore Business Machines
Totl.Business, Totl Software, Inc.
The Personal Finance Assistant, Rainbow Computer Corporation
Budgeteer, Abacus Software
CheckEase, T&F Software Co.
Car Costs, Creative Software
Loan Analyzer, Creative Software

A wide variety of professional business applications is offered by Southern Solutions.

SPREADSHEETS

Busicalc 64, Skyles Electric Works
EasyCalc 64, Commodore Business Machines

The Spreadsheet Assistant, Rainbow Computer Corporation
Practicalc, Computer Software Associates
CalcResult, Computer Marketing Services, Inc.

EDUCATION

Introduction to BASIC I, Commodore Business Machines
Gortek, Commodore Business Machines
Speed/Bingo Math, Commodore Business Machines
Typing Tutor/Word Invaders, Academy Software
Type Attack, Sirius Software
Hey Diddle Diddle, Spinnaker
Rhymes and Riddles, Spinnaker
Kinder Comp, Spinnaker
Facemaker, Spinnaker
Master Type, Lightning Software

TELECOMMUNICATIONS

SuperTerm, Midwest Micro, Inc.
'64 Terminal, Midwest Micro, Inc.
STCP, Eastern House

UTILITIES

GRAPHICS

Sprite Designer, Academy Software
Screen Editor, Commodore Business Machines
Screen Graphics 64, Commodore Business Machines
Chartpak 64, Abacus Software
Scribbler, Syntax Software, Inc.
Doodle, OMNI Unlimited
Spryte Byter, FoxSoft

MUSIC

Music Machine, Commodore Business Machines
Music Composer, Commodore Business Machines
Synthy 64, Abacus Software

BASIC UTILITIES

Super Expander, Commodore Business Machines
Petspeed (BASIC Compiler), Small Systems Engineering
Ultrabasic-64, Abacus Software

MISCELLANEOUS

Pet Emulator (lets you run Commodore programs), Commodore Business Machines

LANGUAGES

Assembler 64, Commodore Business Machines
Logo, Commodore Business Machines
Pilot, Commodore Business Machines
Tiny Forth, Abacus Software
MAE (assembler), Eastern House
C64 Forth, Performance Micro Products

APPENDIX C: COMPUTER MAGAZINES OF INTEREST TO COMMODORE 64 USERS

The following magazines, available at any good newsstand or library, cover Commodore computers specifically:

- *COMPUTE!'s Gazette*
- *Power/Play*
- *Commodore*
- *The Microcomputer Magazine*

Of more general interest are:

- *BYTE*
- *Popular Computing*
- *Creative Computing*

APPENDIX D: LOADING PROGRAMS ON YOUR C64

This appendix is a quick and easy reference guide to loading programs into the Commodore 64 computer. Follow directions carefully so you won't damage the computer.

LOADING A CARTRIDGE PROGRAM

1. Turn on your monitor (TV set).
2. Make sure the computer is turned off.
3. Insert the cartridge label side up in the cartridge slot on the rear of the computer (to the right as you face the keyboard). IF YOUR COMPUTER IS NOT TURNED OFF AS YOU DO THIS, YOU MAY DAMAGE IT.
4. Turn your computer on.

LOADING A CASSETTE PROGRAM

1. Turn your computer and monitor (TV set) on if they aren't on already.
2. Open the Datasette cassette door by pressing the EJECT key.
3. Insert the program cassette in the Datasette recorder, label side up. Press it in firmly, then close the door.
4. Make sure the cassette is rewound to the beginning of the program using the REWIND key.
5. Type LOAD on the computer and hit the RETURN key.
6. When the computer asks you to, press the PLAY key on the Datasette recorder.
7. After the computer has found the program and told you its name (the screen turns light blue while it's searching), press the C= key in the lower left corner of the keyboard.
8. After the program is loaded (you'll see a READY message on the monitor screen), press the STOP key on the Datasette recorder.
9. Type RUN and press RETURN to start the program.

LOADING A DISK PROGRAM

Before starting, one very important message: Handle the disk with care, and only by its outer cover. Don't touch the exposed surface through the slots or bend the cover.

1. Turn on the monitor (TV screen), the disk drive, and then the computer if they aren't already on.
2. If the red "busy" light on the front of the drive is off, open the front drive door by gently pressing in on the latch.
3. Gently insert the disk, label side up and oblong slot to the rear, pressing until it clicks into place.
4. Close the door latch.
5. Type LOAD "program name," 8 on the computer. The program name inside the quotes should be the name of the program you want loaded. Press the RETURN key.
6. After the program is loaded (the computer will give you a READY message), type RUN and press RETURN to start the program.

TURNING OFF THE COMPUTER SYSTEM

1. Be sure to remove any disk from the drive by opening the latch and taking it out. Store it in its proper envelope.
2. Make sure the STOP key of the Datasette has been pressed.
3. Turn off the disk drive, the monitor, and the computer.

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